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

Action Agencies:	Permits and Conservation Division of the Office of Protected Resources, National Oceanic and Atmospheric Administration's National Marine Fisheries Service
Activity Considered:	Issuance of permit No. 18824 to Briana Witteveen for research on marine mammals in the Gulf of Alaska, pursuant to section 10(a)(1) of the Endangered Species Act.
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service
Approved:	PERRY GAYALDO for Donna S. Wieting Director, Office of Protected Resources
Date:	NOV 19 2015
Public Consultation Tracking System (PCTS) number:	FPR-2015-9136

Table of Contents Page

1 Introduction ... 4
- 1.1 Consultation History ... 4

2 Description of the Proposed Action ... 5
- 2.1 Proposed Activities ... 6
  - 2.1.1 Field Activities ... 6
  - 2.1.2 Export of marine mammal parts ... 9
- 2.2 Permit Conditions ... 9
- 2.3 Action Area ... 12
- 2.4 Interrelated and Interdependent Activities ... 12

3 Approach to the Assessment ... 13
- 3.1 Overview of NMFS' Assessment Framework ... 13
- 3.2 Risk Analysis for Endangered and Threatened Species ... 14
- 3.3 Evidence Available for the Consultation ... 16

4 Status of Listed Resources ... 16
- 4.1 Species and Critical Habitat Not Considered Further ... 17
  - 4.1.1 Cetaceans ... 17
  - 4.1.2 Western DPS Steller sea lions ... 18
  - 4.1.3 Leatherback sea turtle ... 20
  - 4.1.4 Fishes ... 20
  - 4.1.5 Critical Habitat ... 20
- 4.2 Species Considered Further in this Opinion ... 21
  - 4.2.1 Blue Whale ... 21
  - 4.2.2 Fin Whale ... 29
  - *4.2.3* Humpback Whale ... 36
  - 4.2.4 North Pacific right whale ... 46
  - 4.2.5 Sei Whale ... 51
  - 4.2.6 Sperm Whale ... 58

5 Environmental Baseline ... 68
- 5.1 Climate Change ... 69
- 5.2 Vessel strike ... 70
- 5.3 Ambient and Anthropogenic Noise ... 71
  - 5.3.1 Deep Water Ambient Noise ... 71
  - 5.3.2 Shallow Water Ambient Noise ... 72
  - 5.3.3 Anthropogenic Sources ... 72
- 5.4 Whaling ... 74
- 5.5 Fisheries Interactions ... 75
- 5.6 Marine Debris ... 76
- 5.7 Scientific Research ... 77
- 5.8 Whale Watching ... 78
- 5.9 U.S. Navy activities ... 79
- 5.10 Large Whale Unusual Mortality Event 2015 ... 79
- 5.11 Recovery Actions in the Action Area ... 80
- 5.12 Conclusion on the Impact of the Environmental Baseline ... 81

6 Effects of the Action on Species and Critical Habitat 81
6.1 Stressors 82
6.2 Stressors Not Likely to Adversely Affect ESA-listed Species 83
6.2.1 Vessel traffic 83
6.2.2 Tag instrument transmissions 84
6.2.3 Echosounder 84
6.2.4 Collection of sloughed skin and prey remains 86
6.2.5 Collection and export of dead animal parts 86
6.3 Stressors Likely to Adversely Affect ESA-listed Species 86
6.3.1 Exposure 86
6.3.2 Response 87
6.4 Cumulative Effects 94
6.5 Integration and Synthesis 95
7 Conclusion 96
8 Incidental Take Statement 97
9 Conservation Recommendations 97
10 Reinitiation of Consultation 98
11 References 99

List of Tables Page

Table 1. Proposed “takes” of listed cetaceans during Briana Witteveen’s research activities in the Gulf of Alaska under permit number 18824.. 5

Table 2. ESA-listed species that may be affected by Briana Witteveen’s marine mammal research activities in the Gulf of Alaska. 16

Table 3. Reported Catch of Endangered Whales Considered in This Opinion, in the North Pacific Ocean 75

Table 4. Authorized takes of listed whales, pinnipeds, and sea turtles in the Pacific Ocean under the Endangered Species Act and the Marine Mammal Protection Act. 78

List of Figures Page

Figure 1. The Action Area for research proposed to be conducted under permit number 18824. 12

Figure 2. Large whale stranding locations in the Western Gulf of Alaska through August 14, 2015. Map sourced from alaskafisheries.noaa.gov 80

1 INTRODUCTION

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. section 7 (a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service (USFWS), NMFS, or both, 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. Section 7 (b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If an incidental take is expected, section 7 (b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with NMFS or the USFWS, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the USFWS concurs with that conclusion (50 CFR §402.14(b)).

For the actions described in this document, the action agency is the National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division.

The biological opinion (Opinion) and incidental take statement portions of this consultation were prepared by NMFS Endangered Species Act Interagency Cooperation Division in accordance with section 7 (b) of the ESA and implementing regulations at 50 CFR §402. This document represents NMFS' final opinion on the effects of these actions on endangered and threatened species and critical habitat that has been designated for those species.

The NMFS completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System.

1.1 Consultation History

On October 7, 2014, NOAA's National Marine Fisheries Service (NMFS), Office of Protected Resources, Permits and Conservation Division (F/PR1) sent application materials to NMFS, Office of Protected Resources, ESA Interagency Cooperation Division (F/PR5) on a proposal to issue a permit for research on the habitat use and foraging ecology of sympatric marine mammals in the Gulf of Alaska.

On December 30, 2014, F/PR5 requested additional information from F/PR1 regarding the application.

On April 17, 2015, F/PR1 provided responses to F/PR5's questions.

On July 15, 2015, F/PR1 requested section 7 consultation with F/PR5.

On August 25, 2015, F/PR5 deemed the application complete and initiated formal consultation with F/PR1.

2 DESCRIPTION OF THE PROPOSED ACTION

The NMFS Office of Protected Resources, Permits and Conservation Division proposes to issue a permit for scientific research pursuant to the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361) and section 10(a)1(A) of the ESA of 1973, as amended. Issuance of permit No. 18824 to Briana Witteveen would authorize research on blue, fin, humpback, North Pacific right, sei, and sperm whales in the Gulf of Alaska. The research aims to improve our understanding of the foraging behavior, prey use, and habitat overlap among sympatric whale species in the Gulf of Alaska. If issued, the permit would be valid for five years (14 May 2015 through 14 May 2020). The proposed actions and "take"[1] authorizations for the species that are listed and proposed for listing can be found in the following table.

Table 1. Proposed "takes" of listed cetaceans during Briana Witteveen's research activities in the Gulf of Alaska under permit number 18824.

Species	Proposed activity/stressor	Life stage and sex	Takes
Steller sea lion – Western DPS	Incidental harassment[1]	All sex and age classes	50
Sei whale	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	All sex and age classes	10
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	Adults and juveniles	40
	Incidental harassment[1]	All sex and age classes	20
Blue whale	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	Male/female; adult/juvenile	10
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	Male/female; adult/juvenile	40

---

[1] Under the MMPA, "take" is defined as to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." [16 U.S.C. 1362(18)(A)] The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The term "harm" is further defined by regulations (50 CFR §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."

Fin whale	Acoustic, active playback/broadcast; Incidental harassment; Instrument, suction-cup (e.g., VHF, TDR); Observations, behavioral; Photo-id[2]	Male/female; adult/juvenile	20
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	All sex and age classes	610
	Incidental harassment; Instrument, suction-cup (e.g., VHF, TDR); Observations, behavioral; Photo-id	Male/female; adult/juvenile	60
	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	All sex and age classes	300
Humpback whale	Acoustic, active playback/broadcast; Incidental harassment; Instrument, suction-cup (e.g., VHF, TDR); Observations, behavioral; Photo-id[2]	Male/female; adult/juvenile	30
	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	All sex and age classes	300
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	All sex and age classes	610
	Incidental harassment; Instrument, suction-cup (e.g., VHF, TDR); Observations, behavioral; Photo-id	Male/female; adult/juvenile	60
North Pacific right whale	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	All sex and age classes	10
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	All sex and age classes	40
Sperm whale	Incidental harassment; Observations, behavioral; Photo-id; Sample, skin and blubber biopsy	All sex and age classes	10
	Acoustic, passive recording; Incidental harassment; Observations, behavioral; Photo-id	All sex and age classes	40
	Incidental harassment[1]	All sex and age classes	20

[1] Incidental harassment during directed research on target species.
[2] Acousonde tag with exposure to acoustic deterrent (F3 pinger).

2.1 Proposed Activities

Activities authorized under the proposed permit include a combination of field research and the export of collected marine mammal parts.

2.1.1 Field Activities

All field research activities will be conducted during open water surveys in the Gulf of Alaska. Surveys will take place primarily between the months of May to October, though the potential exists for surveys to take place during any month or season. All surveys are conducted from small to medium sized vessels measuring less than 25m in length and are powered by either inboard diesel or outboard gas motors. Surveys do not follow a particular route, rather are random in nature and designed to find aggregations of whales. If a non-target species is encountered, the research vessel will make efforts to minimize disturbance by not approaching within 100 yards or halting research operations until the non-target species has left the area. During vessel surveys, any of the following activities may occur:

2.1.1.1 *Close vessel approach; photography*

Close vessel approach will be used for photo-identification, biopsy sampling, and/or to attach a tag. Whales will be approached within one to two body lengths, or sufficiently close to perform research activities. Whales will be approached from behind if obtaining a photo of the ventral surface of the fluke, or perpendicular, if obtaining a photograph of the dorsal fin or flank. Photographs are obtained using a digital SLR camera with 100-300 zooms lens. When approaching for a biopsy sample, approaches are made from an oblique angle from the back such that the vessel would eventually parallel the animal.

Mitigation measures used during close vessel approaches include the following:

- Animals will be approached slowly (< 5 knots) and cautiously.
- The vessel will avoid quick changes in speed or RPMs of the motor.
- Animals will not be approached head on.
- Individual animals will not be approached for longer than one hour per day, or repeatedly in the same day.
- Close approaches will be terminated if animal disturbance is evident (i.e., changes in behavior, stress vocalizations, abrupt shifts in direction of movement).
- Close approaches will not be made in cases of resting or suckling animals.
- All efforts will be made to avoid separating mother and calf pairs.

2.1.1.2 ***Biopsy sampling***

Biopsy sampling will target humpback and fin whales, but blue, North Pacific right, sei, and sperm whales may be approached for biopsy, if encountered. Generally, biopsies will be collected from 10 to 20% of photo-identified individuals. Biopsy samples may be collected from males and females any age class of individual, including calves of fin and humpback whales. Biopsy samples are collected using a small, ultra-light stainless steel dart, which measures approximately 5mm in diameter. The biopsy dart will be fired from a modified .22 pneumatic rifle. The sample is taken from the dorsal flank of the animal. Samples are comprised of skin and a portion of the blubber layer. The biopsy dart does not extend through the blubber to the muscle layer. Most approaches for the purpose of biopsy sampling are successful. It is rare that animals need to be approached more than twice for the purpose of obtaining a biopsy sample.

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

- In most cases, whales will not be biopsied more than once. Duplicate biopsy collection may occur due to difficulty in identifying individual whales in the field.
- Biopsy darts will be cleaned and sanitized following extraction of any tissue before each subsequent use.

2.1.1.3 ***Suction-cup tagging and subsequent research***

Fin and humpback whales will be approached and tagged with suction-cup tags as part of foraging or acoustic deterrent studies. Tagging attempts are successful 25 to 35 percent of the time. A total of 30 successful tag attachments are anticipated annually (i.e., 20 for foraging study, 10 for acoustic deterrent study). All efforts will be made to attach the tag on the dorsal surface of the whale, behind the dorsal fin. Once attached, only the suction cup is in prolonged contact with the whale and contact is limited to the whale's skin. Tags will be released from the whales passively, either through a whale's movements, suction-cup seal leakage, and/or the corrosion of links integrated into the suction cups to allow a more defined time release of the tags. No tag is likely to remain on an individual for longer than 48 hours, with most attachments lasting closer to six to eight hours (Baird et al. 2000, Lerczak et al. 2000, Croll et al. 2001, Calambokidis 2003, Witteveen et al. 2008). Researchers do not anticipate tagging the same animal more than once during the field season, but multiple tag attachments are possible, though highly unlikely, across years.

The researchers will employ two suction-cup tagging methodologies:

Remotely deployed tags: Remotely deployed tags will be attached to whales with a single suction cup. Tags will be deployed by means of a pneumatic launcher at a distance of 5 to 15 m, maximizing the distance between the boat and the whale. The launcher is made of aluminum and comprised of an air tank and a barrel. The air tank is filled with compressed air (filled through a scuba tank) and is released/fired with a solenoid-valve trigger. In addition, a valve allows for air to be released from the tank to reduce pressure and, thus, reduce the force behind the deployment if the approach distance should decrease. Tag components are housed in machined aluminum cylinders (50.5 cm max length, 4.0 cm diameters, 0.38 kg max weight) and contain either an acoustic time depth transmitter (ATDT; V16P or V22P continuous transmitter, VEMCO, Halifax, NS) or archival time depth recorder (LTD_1100, Lotek, St. John's, NL). All tags will contain a VHF transmitter (MOD125, Telonics, Mesa, AZ).

Pole deployed tags: The Acousonde 3A, a tag designed to record three dimensional movements and sounds of whales, is sensitive to impacts and cannot be remotely deployed. Therefore, this tag type must be deployed with a carbon fiber wind surfing mast. The end of the mast is equipped with a PVC coupling, designed to loosely hold the tag body during approaches, but to release the tag when contact with the whale is made. The Acousonde tags contain an archival unit (Model 03A, Greeneridge Sciences, Inc, Santa Barbara), are equipped with a VHF transmitter (MM210B, Advanced Telemetry Systems, Isanti, MN), and are housed within syntactic foam for protection.

For research on foraging behavior, focal follows will occur following successful tag attachment. Focal follows are necessary so that tagging data can be related to observed surface behaviors and habitat use, and to allow for successful tag recovery. Focal follows will occur from a distance of 100-500 yards, and will not last longer than eight hours per individual or group.

For research on the effectiveness and impacts of acoustic deterrents, each whale will be monitored for approximately one hour following successful tag attachment in order to establish pre-acoustic deterrent dive patterns and behaviors. While continuing to monitor whale behavior, an acoustic deterrent device (F3 'pinger', Future Oceans, Australia) will be set in the water to at least one meter depth. An Acousonde tag will record the received sound level (dB) of the pinger as received by the whale. It will also simultaneously record changes in the whale's swim direction, pitch, and speed. Any observed abrupt changes in these parameters immediately after acoustic deterrent device deployment signify a response to the sound generated. The F3 pinger that will be tested is currently being used by commercial fisherman throughout the state of Alaska to deter cetaceans from entanglement in fishing gear.

In addition to the mitigation measures described above for close approach, mitigation measures using during suction-cup tagging and subsequent field studies include:

- No animal will be knowingly approached for a tagging attempt more than 4 times.
- Mother and calf pairs will not be tagged.
- All equipment (including tags) used for tagging is cleaned and sterilized between uses.
- If a whale changes direction and moves toward the vessel during a focal follow, the engine will be placed in neutral to let the whale pass.
- Acoustic deterrent devices will not be deployed in such a way as to injure a whale

2.1.1.4 *Collection of parts*

Parts of marine mammals may be collected following a killer whale predation event using a skim net or sieve. Prey remains would be collected after killer whales depart the area. In addition, sloughed skin from humpback whales will be collected following certain surface activities (i.e. breaching, tail slapping). Sloughed skin will be collected from the site of the surface activity only after the whale has moved greater than 100 yards from the location.

2.1.2 Export of marine mammal parts

Marine mammal parts may be exported to Canada from the United States for species and/or sex identification (in the case of killer whale prey parts) or for stock identification, sex, pregnancy or paternity. Marine mammal samples, including biopsy samples, may have come from lactating, pregnant or unweaned marine mammals. Some biopsy samples will be from unweaned animals, since we are requesting to biopsy calves. Calves in Alaska are no longer newborns and are generally older than 6 months of age, however, they are often still suckling. In the case of prey parts the animal would have died as the result of predation prior to collection. Sloughed skin is a natural process and collection does not alter the animal's state (live or dead). No live animals will be imported or exported. In the event that marine mammal parts are to be shipped out of the country, the proper permit will be obtained through the appropriate permitting agency.

2.2 Permit Conditions

The proposed Permit No. 18824 includes several terms and conditions intended to:

- Minimize the potential adverse effects of the research activities on the species considered in this Opinion;
- Reduce the number of “takes” of the ESA-listed species considered in this Opinion.

The following terms and conditions developed by the Permits Division are included in the draft permit (please refer to the permit document for a complete list of terms and conditions):

- Researchers must immediately stop permitted activities and the Permit Holder must contact the Chief, NMFS Permits and Conservation Division (hereinafter "Permits Division") for written permission to resume if any of the following occurs:
  - Serious injury or mortality[2] of a protected species;
  - If more animals are taken than authorized, if animals are taken in a manner not authorized by the proposed permit, or if protected species other than those authorized by this permit are taken.
- No individual animal may be taken more than four times in one day.
- To minimize disturbance of the subject animals the Permit Holder must exercise caution when approaching animals and must retreat from animals if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions.
- Where females with calves are authorized to be taken, researchers:
  - must immediately terminate efforts if there is any evidence that the activity may be interfering with pair-bonding or other vital functions;
  - must not position the research vessel between the mother and calf;
  - must approach mothers and calves gradually to minimize or avoid any startle response;
  - must not approach any mother or calf while the calf is actively nursing;
  - must, if possible, sample the calf first to minimize the mother's reaction when sampling mother/calf pairs.
- During biopsy sampling and tagging activities, the following conditions must be met:
  - All biopsy tips must be disinfected between and prior to each use.
  - Only adults, juveniles and calves 6 months of age or older may be tagged, including females with calves.
  - Before attempting to sample (tagging or biopsy) an individual, Researchers must take reasonable measures (e.g., compare photo-identifications) to avoid unintentional repeated sampling of any individual.
  - A tag attachment, or biopsy attempt must be discontinued if an animal exhibits repetitive strong adverse reactions to the activity or the vessel.
  - In no instance will the Permit Holder attempt to biopsy or tag a cetacean anywhere forward of the pectoral fin.

---

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

- During the evaluation of acoustic deterrents, a playback episode must be discontinued if an animal exhibits repetitive strong adverse reactions to the playback activity or the vessel.
- Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities.
- Personnel involved in permitted activities must be reasonable in number and essential to conduct of the permitted activities. Essential personnel are limited to:
    - 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);
    - individuals included as backup for those personnel essential to the conduct of the permitted activity; and
    - individuals included for training purposes.
- The Chief, Permits Division must grant written approval for all personnel performing activities not essential to achieving the research objectives to be present during research activities. These non-essential personnel may not influence the conduct of permitted activities, results in takes of protected species, participate in permitted activities, provide compensation to the permit holder or researchers for allowing them to accompany the researchers.
- Persons who are required to have state or Federal licenses to conduct activities authorized under the permit (e.g., veterinarians, pilots) must be duly licensed when undertaking such activities.
- The permit cannot be transferred or assigned to any other person.
- The permit holder must submit annual and final reports to the Permits Division regarding all research activities conducted under the proposed permit. Reports must include a tabular accounting of takes and a narrative description of activities and effects.
- If exceedance of take occurs, or if serious injury or mortality of ESA-listed species results from the proposed research, incident reports must be submitted to the Permits Division within two weeks of the event.
    - Incident reports must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceedance of authorized take.
    - In addition to the written report, the Permit Holder must contact the Permits Division by phone as soon as possible, but no later than within two business days of the incident.
    - 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 the permit.
- To the maximum extent practical, the Permit Holder must coordinate permitted activities with activities of other Permit Holders conducting the same or similar activities on the

same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals.

2.3 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 CFR 402.02). Proposed field activities will occur in the Gulf of Alaska, and will be focused on marine waters surrounding Kodiak Island and Shumagin Islands (Figure 1).

Figure 1. The Action Area for research proposed to be conducted under permit number 18824.

2.4 Interrelated and Interdependent Activities

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. NMFS determined that there are no interrelated and interdependent actions outside the scope of this consultation.

3 APPROACH TO THE ASSESSMENT

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

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

The adverse modification analysis considers the impacts on the conservation value of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[3]

3.1 Overview of NMFS' Assessment Framework

We will use the following approach to determine whether the proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area including:
    - The past and present impacts of Federal, state, or private actions and other human activities in the action area.
    - The anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation.
    - The impacts of state or private actions that are contemporaneous with the consultation in process.
- Analyze the effects of the proposed action on both species and their habitat.
    - We consider how the proposed action would affect the species' reproduction, numbers, and distribution.
    - We evaluate the proposed action's effects on critical habitat features.
- Describe any cumulative effects in the action area.

---

[3] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

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

- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
  - We add the effects of the action to the *Environmental Baseline* and the *Cumulative Effects* to assess whether the action could reasonably be expected to:
    - Reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or
    - Reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the Status of the Species and critical habitat.
- Reach jeopardy and adverse modification *Conclusion*. In this step we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat. These conclusions flow from the logic and rationale presented in the *Integration and Synthesis*.
- If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

3.2 Risk Analysis for Endangered and Threatened Species

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct populations of vertebrate species. Because the continued existence of species depends on the fate of the populations that comprise them, the continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the population that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population level risks to the species those populations comprise. We measure risks to listed individuals using the individual's "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

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

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

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

3.3 Evidence Available for the Consultation

To conduct these analyses, we rely on all of the evidence available to us. This evidence consists of monitoring reports submitted by past and present permit holders, the information provided by the Permits Division when it initiates formal consultation, and the general scientific literature.

During this consultation, we conducted electronic searches of the general scientific literature. These searches specifically try to identify data or other information that supports a particular conclusion (for example, a study that suggests whales will exhibit a particular response to approach) as well as data that does not support our conclusion. When data are equivocal, or in the face of substantial uncertainty, our decisions are designed to avoid the risks of inaccurately concluding that an action would not have an adverse effect on listed species.

4 STATUS OF LISTED RESOURCES

This section identifies the ESA-listed species that may be affected by the issuance of permit No. 18636 (Table 2). It then summarizes the biology and ecology of those species and what is known about their life histories in the Action Area.

Table 2. ESA-listed species that may be affected by Briana Witteveen's marine mammal research activities in the Gulf of Alaska.

Species	ESA Status	Critical Habitat
Cetaceans		
Beluga whale (*Delphinapterus leucas*) – Cook Inlet DPS	E – 73 FR 62919	-- --
Blue whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --
Fin whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --
Humpback whale (*Megaptera novaeangliae*)	E – 35 FR 18319	-- --
North Pacific right whale (*Eubalaena japonica*)	E – 73 FR 12024	73 FR 19000**
Sei whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --
Sperm whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --
Gray whale (*Eschrichtius robustus*) – Western North Pacific DPS	E – 35 FR 18319	-- --
Pinnipeds		
Steller sea lion (*Eumetopias jubatus*) – Western DPS	E – 62 FR 24345	58 FR 45269
Sea turtles		
Leatherback sea turtle (*Dermochelys coriacea*)	E – 35 FR 8491	-- --
Fishes		
Chinook salmon (*Oncorhynchus tshawytscha*)		
California coastal ESU	T – 64 FR 50393	-- --
Central Valley spring-run ESU	T – 64 FR 50393	-- --
Lower Columbia River ESU	T – 64 FR 14308	-- --
Upper Columbia River spring-run ESU	E – 64 FR 14308	-- --
Puget Sound ESU	T – 64 FR 14308	-- --
Sacramento River winter-run ESU	E – 59 FR 440	-- --
Snake River fall-run ESU	T – 57 FR 14653	-- --
Snake River spring/summer-run ESU	T – 57 FR 14653	-- --
Upper Willamette River spring-run ESU	T – 64 FR 14308	-- --

Chum salmon (*Oncorhynchus keta*)		
Columbia River ESU	T – 64 FR 14507	-- --
Hood Canal summer-run ESU	T – 64 FR 14507	-- --
Coho salmon (*Oncorhynchus kisutch*)		
Central California coast ESU	E – 70 FR 37160	-- --
Lower Columbia River ESU	T – 70 FR 37160	-- --
Oregon coast ESU	T – 73 FR 7816	-- --
Southern Oregon and Northern California coasts ESU	T – 62 FR 24588	-- --
Eulachon (*Thaleichthys pacificus*)		
Southern DPS	T – 75 FR 13012	-- --
Sockeye salmon (*Oncorhynchus nerka*)		
Ozette Lake ESU	T – 64 FR 14528	-- --
Snake River ESU	E – 56 FR 58619	-- --
Steelhead (*Oncorhynchus mykiss*)		
Puget Sound DPS	T – 72 FR 26722	-- --
Central California coast DPS	T – 62 FR 43937	-- --
Snake River Basin DPS	T – 62 FR 43937	-- --
Upper Columbia River DPS	T – 74 FR 42605	-- --
Southern California DPS	E – 62 FR 43937	-- --
Middle Columbia River DPS	T – 64 FR 14517	-- --
Lower Columbia River DPS	T – 63 FR 13347	-- --
Upper Willamette River DPS	T – 64 FR 14517	-- --
Northern California DPS	T – 65 FR 36074	-- --
South-Central California coast DPS	T – 62 FR 43937	-- --
California Central Valley DPS	T – 63 FR 13347	-- --

**The study area is close to designated Critical Habitat for North Pacific right whale, but does not overlap.

4.1 Species and Critical Habitat Not Considered Further

Directed research would target blue, fin, humpback, North Pacific right, sei, gray, and sperm whales. The Western DPS of Steller sea lions are non-target animals that could be harassed. ESA-listed resources occurring within the Action Area that are either not likely to be exposed to the proposed research, or are not likely to be adversely affected are discussed below.

4.1.1 Cetaceans

Cook Inlet Beluga whales and Western North Pacific gray whales could occur in the Action Area.

4.1.1.1 *Cook Inlet Beluga whales*

Though rare, Beluga whales, likely from the Cook Inlet DPS, have been observed in the vicinity of Kodiak Island (Laidre et al. 2000), one of the focus areas of the proposed research. The research vessel will have trained observers onboard that will assist in avoiding non-target species, such as Beluga whales. If an individual or group is encountered, the research vessel will make efforts to minimize disturbance by not approaching within 100 yards or halting research operations until the whales have left the area. Additionally, the slow transit speeds of the research vessel should minimize the possibility of a ship strike (Section 6.2.1 has further detail on potential impacts from research vessel traffic). For these reasons, we did not consider Beluga whales further in this Opinion.

4.1.1.2 *Western North Pacific DPS gray whales*

Gray whales throughout the North Pacific Ocean were originally listed on June 2, 1970 (35 FR 8495). On June 16, 1994 (59 FR 21094), the eastern North Pacific gray whales were delisted, but western North Pacific gray whales remain listed through the present as endangered.

Eastern and western North Pacific gray whales were once considered geographically separated along either side of the ocean basin, but recent photo-identification, genetic, and satellite tracking data refute this. Two western North Pacific gray whales have been satellite tracked from Russian foraging areas east along the Aleutian Islands, through the Gulf of Alaska, and south to the Washington State and Oregonian coasts in one case (Mate et al. 2011) and to the southern tip of Baja California and back to Sakhalin Island in another (IWC 2012). Comparisons of eastern and western North Pacific gray whale catalogues have thus far identified 23 western gray whales occurring on the eastern side of the basin during winter and spring (Weller et al. 2013). Burdin et al. (2011) found an additional individual. During one field season off Vancouver Island, western gray whales were found to constitute 6 of 74 (8.1 percent) of photo-identifications (Weller et al. 2012).

Alter et al. (2007) concluded that eastern and western North Pacific gray whales historically numbered between 76,000 and 118,000 individuals combined prior to whaling; the proportion of individuals that was in each population is unknown. However, whaling dramatically reduced the population to a tiny fraction of its former abundance, with 100 to 130 non-calves remaining (Burdin et al. 2010; Cooke et al. 2005; Cooke et al. 2008; Reeves et al. 2008; Wade et al. 2003a; Weller et al. 2005; Weller et al. 2006). The most recent abundance estimate of the western North Pacific gray whale population is 140 individuals (Carretta et al. 2015, unpublished 2014 stock assessment reports). The population was believed to be extinct in the 1970's (Bradford et al. 2003). At least 1,700 to 2,000 individuals were commercially harvested from the late 1800's to the mid-20th century (Commission 2004; IWC 2003). Findings that eastern North Pacific gray whales may be found within the range of western North Pacific gray whales may mean that even fewer individuals compose the western population, as individuals formerly believed to be western individuals may actually be part of the eastern population (Lang et al. 2010). The most recent abundance estimate of the eastern North Pacific gray whale population is 19,126 individuals.

The applicant will target gray whales during field research activities. However, based on the relative abundance of the western versus eastern North Pacific DPS in the Action Area, we believe the likelihood of the researchers interacting with individuals from the western North Pacific DPS to be discountable.

4.1.2 Western DPS Steller sea lions

Steller sea lions were originally listed as threatened under the ESA on November 26, 1990 (55 FR 49204), following a decline in the U.S. of about 64% over the previous three decades. In 1997, the species was split into two separate populations based on demographic and genetic differences (Bickham et al. 1996; Loughlin 1997), and the western population was reclassified to endangered (62 FR 24345) while the eastern population remained threatened (62 FR 30772). On April 18, 2012, the NMFS proposed to delist the eastern DPS of Steller sea lions (77 FR 23209). On November 4, 2013, the NMFS announced that as of December 4, 2013, the eastern DPS of Steller sea lions would be delisted and no longer protected under the ESA (78 FR 66139).

Steller sea lion centers of abundance and distribution are in Gulf of Alaska and the Aleutian Islands (NMFS 1992), and therefore could occur in the Action Area in the marine waters around Kodiak Island and the Shumagin Islands. The NMFS currently estimates the western DPS to have 52,209 individuals (Allen and Angliss 2013). Although data vary for the 31 major rookeries, as a whole, the DPS has been increasing in size by an average of 1.8% annually from 2001-2011 (Allen and Angliss 2013).

Most adult Steller sea lions occupy rookeries during the summer pupping and breeding season and exhibit a high level of site fidelity. During the breeding season, some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts (sites that provide regular retreat from the water on exposed rocky shoreline, gravel beaches, and wave-cut platforms or ice; (Ban 2005; Call and Loughlin 2005; Rice 1998a). Adult males may disperse widely after the breeding season. During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly on terrestrial sites but also on sea ice in the Bering Sea. Western Stellers appear to be moving from western Alaska to the central and eastern Gulf of Alaska areas (Fritz et al. 2013). Diving activity is highly variable in Steller sea lion by sex and season. During the breeding season, when both males and females occupy rookeries, adult breeding males rarely, if ever, leave the beach (Loughlin 2002). However, females tend to feed at night on one to two day trips and return to nurse pups (NRC 2003a). Female foraging trips during winter are longer (130 km) and dives are deeper (frequently greater than 250 m). Summer foraging dives, however, are closer to shore (about 16 km) and shallower (100-250 m; (Loughlin 2002; Merrick and Loughlin 1997)). As pups mature and start foraging for themselves, they develop greater diving ability until roughly 10 years of age (Pitcher et al. 2005). Juveniles usually make shallow dives of 70-140 m over 1-2 minutes, but much deeper dives in excess of 300 m are known (Loughlin et al. 2003; Merrick and Loughlin 1997; Rehberg et al. 2001). Young animals also tend to stay in shallower water less than 100 m deep and within 20 km from shore (Fadely et al. 2005).

Based on the species' distribution, life history, and the location of the proposed research, Western DPS Steller sea lions could come in close proximity to vessels during research activities. However, we would expect Steller sea lions to react in a similar, or less severe, manner to the research vessel as those animals that are being targeted. That is, we would expect Steller sea lions that may be in close proximity to the research vessel to exhibit either no visible reaction or short-term low-level to moderate behavioral responses (e.g., temporarily leaving the immediate area of the field research; for further detail on expected reactions, see the *Effects* section of this Opinion). Additionally, we do not believe Steller sea lions are at risk of being struck by research vessels due to their mobility and because we expect the Applicant would be able to locate, identify, and avoid all sea lions during transit and research activities. For these reasons, it is unlikely that the proposed action will adversely affect Western DPS Steller sea lions and we do not consider this species further in this Opinion.

4.1.3 Leatherback sea turtle

Authorized activities would not be conducted in sea turtle critical habitat or near nesting sites. We believe that encounters with Leatherback sea turtles would be uncommon due to the fact that proposed activities are designed with the purpose of finding and conducting research on cetaceans and the low overall density of leatherback sea turtles (particularly since this research will occur at the northern edge of the species' range). The research vessel will have trained observers onboard that will assist in avoiding non-target species, such as Leatherback sea turtles. If a Leatherback sea turtle is encountered, the research vessel will make efforts to minimize disturbance by not approaching within 100 yards or halting research operations until the individual has left the area. Additionally, the slow transit speeds of the research vessel should minimize the possibility of a ship strike. It is therefore unlikely that the proposed action will adversely affect Leatherback sea turtles and we did not consider the species further in this Opinion.

4.1.4 Fishes

The ESA-listed fish species that may occur in the Action Area spend years in the marine environment before returning to natal streams to spawn. However, research efforts under the proposed permit would be conducted in ways that should only affect target cetaceans. No netting, hooks, or other devices would be placed in the water column that could pose a risk to fish species. Additionally, we consider it highly unlikely that listed fish species would be exposed to ship strikes and consider any threats posed by this stressor to be discountable. For these reasons, we did not consider any ESA-listed fish species further in this Opinion.

4.1.5 Critical Habitat

4.1.5.1 ***Western DPS Steller sea lion***

The proposed action will occur within designated Critical Habitat for Western DPS Steller sea lions. Critical habitat for the species was designated on August 27, 1993 (58 FR 45269). In Alaska, major Steller sea lion rookeries, haulouts, and associated terrestrial, air, and aquatic zones are designated as critical habitat. Terrestrial and air zones of rookeries and haulouts will not be affected by this action because research activities will only occur in the aquatic environment. Aquatic areas surrounding major rookeries and haulout sites, where the proposed action will occur, provide foraging habitats, prey resources, and refuge considered essential to the conservation of Steller sea lions. Proposed research activities will not affect prey resources, and only disturb foraging behavior and use of refuge habitat at the surface of the water temporarily. It is expected that Steller sea lions would resume normal foraging and use of refuge habitat shortly after researchers leave the area. Therefore, the proposed activities are not likely to adversely affect the conservation value of the designated critical habitat for Steller sea lions, and Steller sea lion critical habitat is not addressed further in this Opinion**.**

4.1.5.2 ***North Pacific Right whale***

In July 2006, NMFS designated two areas as critical habitat for right whales in the North Pacific (71 FR 38277). The areas encompass about 36,750 square miles of marine habitat, which include feeding areas within the Gulf of Alaska and the Bering Sea that support the species. The primary constituent element to this critical habitat is the presence of large copepods and oceanographic factors that concentrate this prey of North Pacific right whales. At present, this Primary Constituent Element has not been significantly degraded due to human activity. However, significant concern has been voiced regarding the impact that oceanic contamination of pollutants may have on the food chain and consequent bioaccumulation of toxins by marine predators. Changes due to global warming have also been raised as a concern that could affect the distribution or abundance of copepod prey for several marine mammals, including right whales.

The study area is close to designated Critical Habitat for North Pacific right whale, but does not overlap. Sounds from research activities, including from the operation of acoustic deterrents and vessels, have the potential to reach North Atlantic right whale critical habitat in the Gulf of Alaska. However, any sound that does reach critical habitat will be reduced to negligible levels due to transmission loss. We consider the effects of these low levels sounds to be insignificant. Therefore, the proposed action is not likely to adversely affect the conservation value of, nor destroy or adversely modify, the critical habitat that has been designated for, North Pacific right whales. As a result, critical habitat of North Pacific right whales will not be considered further in this opinion.

4.2 Species Considered Further in this Opinion

Based on the anticipated exposure and response of species to stressors, we identified the endangered and threatened species that are likely to be adversely affected by the proposed research activities. This section of the Opinion consists of narratives for each of the threatened and endangered species that occur in the Action Area and that may be adversely affected by the proposed research activities. In each narrative, we present a summary of information on each species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

4.2.1 Blue Whale

The blue whale, *Balaenoptera musculus* (Linnæus 1758), is a cosmopolitan species of baleen whale. It is the largest animal ever known to have lived on Earth: adults in the Antarctic have reached a maximum body length of about 33 m (108 ft) and can weigh more than 150,000 kg (330,700 lbs). The largest blue whales reported from the North Pacific are a female that measured 26.8 m (88 ft) taken at Port Hobron in 1932 (Reeves et al. 1985) and a 27.1 m (89 ft) female taken by Japanese pelagic whaling operations in 1959 (NMFS 1998).

As is true of other baleen whale species, female blue whales are somewhat larger than males. Blue whales are identified by the following characteristics: a long-body and comparatively slender shape; a broad, flat "rostrum" when viewed from above; a proportionately smaller dorsal fin than other baleen whales; and a mottled gray color pattern that appears light blue when seen through the water. Blue whales may reach 70 to 80 years of age (COSEWIC 2002; Yochem and Leatherwood 1985).

4.2.1.1 ***Distribution***

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

4.2.1.2 ***Population Structure***

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

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

Until recently, blue whale population structure had not been tested using molecular or nuclear genetic analyses (Reeves et al. 1998). A recent study by Conway (2005) suggested that the global population could be divided into four major subdivisions, which roughly correspond to major ocean basins: eastern North and tropical Pacific Ocean, Southern Indian Ocean, Southern Ocean, and western North Atlantic Ocean. The eastern North/tropical Pacific Ocean subpopulation includes California, western Mexico, western Costa Rica, and Ecuador, and the western North Pacific Ocean subpopulation (including blue whales in the Action Area) (Conway 2005). Genetic studies of blue whales occupying a foraging area south of Australia (most likely pygmy blue whales) have been found to belong to a single population (Attard et al. 2010). For this Opinion, blue whales are treated as four distinct populations as outlined by Conway (2005).

Blue whales occur widely throughout the North Pacific. Acoustic monitoring has recorded blue whales off Oahu and the Midway Islands, although sightings or strandings in Hawaiian waters have not been reported (Barlow et al. 1997; Northrop et al. 1971; Thompson and Friedl 1982). Nishiwaki (1966) notes blue whale occurrence among the Aleutian Islands and in the Gulf of Alaska, but until recently, no one has sighted a blue whale in Alaska for some time, despite several surveys (Carretta et al. 2005; Forney and Brownell Jr. 1996a; Leatherwood et al. 1982; Stewart et al. 1987), possibly supporting a return to historical migration patterns (Anonmyous. 2009).

Blue whales are thought to summer in high latitudes and move into the subtropics and tropics during the winter (Yochem and Leatherwood 1985). Minimal data suggest whales in the western region of the North Pacific may summer southwest of Kamchatka, south of the Aleutians, and in the Gulf of Alaska, and winter in the lower latitudes of the western Pacific (Sea of Japan, the East China, Yellow, and Philippine seas) and less frequently in the central Pacific, including Hawaii (Carretta et al. 2005; Stafford 2003; Watkins et al. 2000), although this population is severely depleted or has been extirpated (Gilpatrick and Perryman. 2009). However, acoustic recordings made off Oahu showed bimodal peaks of blue whales, suggesting migration into the area during summer and winter (McDonald and Fox 1999; Thompson and Friedl 1982).

Blue whales from both the eastern and western North Pacific have been heard, tracked, or harvested in waters off Kodiak Island; acoustic detections are made in the Gulf of Alaska from mid-July to mid-December and a peak from August through November (COSEWIC 2002; Ivashin and Rovnin. 1967; Moore et al. 2006; Stafford et al. 2007; Yochem and Leatherwood 1985). Although acoustic detections in the Gulf of Alaska were absent since the late 1960s, recordings have increased during 1999 to 2002 and a few sightings have been made in the northern Gulf of Alaska (Calambokidis et al. 2009; Moore et al. 2006; NOAA 2004; Stafford 2003; Stafford et al. 2007; Stafford and Moore 2005a). However, surveys in the western Gulf of

Alaska and east of Kodiak Island have not found blue whales (Rone et al. 2010; Zerbini et al. 2006). Blue whales are rarely observed in nearshore Alaskan waters, but seem to prefer continental shelf edge waters; such areas in the Gulf of Alaska were formerly feeding grounds for blue whales prior to severe depletion (Rice and Wolman. 1982). Call detections of blue whales from the western North Pacific indicate a greater likelihood of these individual occurring southwest of Kodiak Island (Stafford 2003).

4.2.1.3 ***Reproduction***

Gestation takes 10 to 12 months, followed by a 6 to 7 month nursing period. Sexual maturity occurs at 5 to 15 years of age and calves are born at 2 to 3 year intervals (COSEWIC 2002; NMFS 1998; Yochem and Leatherwood 1985). Recent data from illegal Russian whaling for Antarctic and pygmy blue whales support sexual maturity at 23 m and 19 to 20 m, respectively (Branch and Mikhalev 2008). The mean intercalving interval in the Gulf of California is roughly two and a half years (Sears et al. 2014). Once mature, females return to the same areas where they were born to give birth themselves (Sears et al. 2014).

4.2.1.4 ***Movement***

Blue whales are highly mobile, and their migratory patterns are not well known (Perry et al. 1999; Reeves et al. 2004). Blue whales migrate toward the warmer waters of the subtropics in fall to reduce energy costs, avoid ice entrapment, and reproduce (NMFS 1998). Satellite tagging indicates that, for blue whales tagged off Southern California, movement is more linear and faster (3.7 km/h) while traveling versus while foraging (1.7 km/h)(Bailey et al. 2009). Residency times in what are likely prey patches averages 21 days and constituted 29 percent of an individual's time overall, although foraging could apparently occur at any time of year for tagged individuals (Bailey et al. 2009). Broad scale movements also varied greatly, likely in response to oceanographic conditions influencing prey abundance and distribution (Bailey et al. 2009). Blue whales along Southern California were found to be traveling 85 percent of the time and milling 11 percent (Bacon et al. 2011).

4.2.1.5 ***Feeding***

Data indicate that some summer feeding takes place at low latitudes in upwelling-modified waters, and that some whales remain year-round at either low or high latitudes (Clarke and Charif 1998; Hucke-Gaete et al. 2004; Reilly and Thayer 1990; Yochem and Leatherwood 1985). One population feeds in California waters from June to November and migrates south in winter/spring (Calambokidis et al. 1990; Mate et al. 1999). Prey availability likely dictates blue whale distribution for most of the year (Burtenshaw et al. 2004; Clapham et al. 1999; Sears 2002 as cited in NMFS 2006a). The large size of blue whales requires higher energy requirements than smaller whales and potentially prohibits fasting Mate et al. (1999). Krill are the primary prey of blue whales in the North Pacific (Kawamura 1980; Yochem and Leatherwood 1985). Blue whales typically occur alone or in groups of up to five animals, although larger foraging aggregations of up to 50 have been reported including aggregations mixed with other rorquals such as fin whales (Corkeron et al. 1999; Shirihai 2002). While feeding, blue whales show slowed and less obvious avoidance behavior then when not feeding (Sears et al. 1983 as cited in NMFS 2005).

4.2.1.6 ***Diving and Social Behavior***

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

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

Satellite tagging indicates that, for blue whales tagged off Southern California, movement is more linear and faster (3.7 km/h) while traveling versus while foraging (1.7 km/h)(Bailey et al. 2009). Residency times in what are likely prey patches averages 21 days and constituted 29 percent of an individual's time overall, although foraging could apparently occur at any time of year for tagged individuals (Bailey et al. 2009). Broad scale movements also varied greatly, likely in response to oceanographic conditions influencing prey abundance and distribution (Bailey et al. 2009). Blue whales along Southern California were found to be traveling 85 percent of the time and milling 11 percent (Bacon et al. 2011). While feeding, blue whales show slowed and less obvious avoidance behavior then when not feeding (Sears et al. 1983 as cited in NMFS 2005).

4.2.1.7 ***Vocalization and Hearing***

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5 to 400 Hz, with dominant frequencies from 16 to 25 Hz, and songs that span frequencies from 16 to 60 Hz that last up to 36 seconds repeated every 1 to 2 minutes (see McDonald et al. 1995). Berchok et al. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0 to 78.7 Hz. Reported source levels are 180 to 188 dB re 1μPa, but may reach 195 dB re 1μPa (Aburto et al. 1997; Clark and Gagnon 2004; Ketten 1998; McDonald et al. 2001). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re 1 μPa_{rms} -1 m in the 17 to 30 Hz range and pygmy blue whale calls at 175± 1 dB re 1 μPa_{rms} -1 m in the 17 to 50 Hz range.

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

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

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

Blue whale songs consist of repetitively patterned sounds produced over time spans of minutes to hours, or even days (Cummings and Thompson 1971; McDonald et al. 2001). The songs are divided into pulsed/tonal units, which are continuous segments of sound, and phrases, which are repeated combinations of 1 to 5 units (Mellinger and Clark 2003; Payne and McVay 1971). A song is composed of many repeated phrases. Songs can be detected for hundreds, and even thousands of kilometers (Stafford et al. 1998), and have only been attributed to males (McDonald et al. 2001; Oleson et al. 2007a). Worldwide, songs are showing a downward shift in frequency

(Mcdonald et al. 2009). For example, a comparison of recordings from November 2003 and November 1964 and 1965 reveals a long-term shift in the frequency of blue whale calling near San Nicolas Island. In 2003, the spectral energy peak was 16 Hz compared to ~22.5 Hz in 1964 and 1965, illustrating a more than 30 percent shift in call frequency over four decades (McDonald et al. 2006b). 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 7 of the world's 10 known blue whale songs originating in the Atlantic, Pacific, Southern, and Indian Oceans. Many possible explanations for the shifts exist, but none have emerged as the probable cause.

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

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

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

4.2.1.8 ***Status and Trends***

Blue whales (including all subspecies) were originally listed as endangered in 1970 (35 FR 18319), and this status has continued since the inception of the ESA in 1973. Blue whales are also listed as endangered on the IUCN Red List of Threatened Animals (IUCN 2010) and are protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for blue whales.

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

Estimates of blue whale abundance in the North Pacific are uncertain. Prior to whaling, Gambell (1976) reported there may have been as many as 4,900 blue whales. Blue whales were hunted in the Pacific Ocean, where 5,761 were killed from 1889 to 1965 (Perry et al. 1999). This estimate does not account for under-reporting by Soviet whalers, who took approximately 800 more individuals than were reported (Ivashchenko et al. 2013). The IWC banned commercial whaling in the North Pacific in 1966, although Soviet whaling continued after the ban. Although blue whale abundance has likely increased since its protection in 1966, the possibility of unauthorized harvest by Soviet whaling vessel, incidental ship strikes, and gillnet mortalities make this uncertain. Punt (2010) estimated the rate of increase for blue whales in the eastern North Pacific to be 3.2 percent annually (1.4 SE) between 1991 and 2005, while Calambokidis et al. (2010) estimated a growth rate of 3 percent annually.

4.2.1.9 ***Natural Threats***

As the world’s largest animals, blue whales are only occasionally known to be killed by killer whales (Sears et al. 1990; Tarpy 1979). Blue whales engage in a flight response to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Blue whales are known to become infected with the nematode *Carricauda boopis*, which are believed to have caused mortality in fin whale due to renal failure (Lambertsen 1986).

4.2.1.10 ***Anthropogenic Threats***

Blue whales have faced threats from several historical and current sources. Blue whale populations are severely depleted originally due to historical whaling activity.

Increasing oceanic noise may impair blue whale behavior. Although available data do not presently support traumatic injury from sonar, the general trend in increasing ambient low-frequency noise in the deep oceans of the world, primarily from ship engines, could impair the ability of blue whales to communicate or navigate through these vast expanses (Aburto et al. 1997; Clark 2006). Blue whales off California altered call levels and rates in association with changes in local vessel traffic (Mckenna 2011).

Ship strikes were implicated in the deaths of five blue whales, from 2004 to 2008 (Carretta et al. 2012). Four of these deaths occurred in 2007, the highest number recorded for any year. During 2004 to 2008, there were an additional eight injuries of unidentified large whales attributed to ship strikes. Ship strike is an issue for blue whales of Sri Lanka engaged in foraging in shipping lanes, with several individuals stranding or being found with evidence of being struck (De Vos et al. 2013; Ilangakoon 2012).

There is a paucity of contaminant data regarding blue whales. Available information indicates that organochlorines, including dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyls (PCB), benzene hexachloride (HCH), hexachlorobenzene (HCB), chlordane, dieldrin, methoxychlor, and mirex have been isolated from blue whale blubber and liver samples (Gauthier et al. 1997; Metcalfe et al. 2004). Contaminant transfer between mother and calf occurs, meaning that young often start life with concentrations of contaminants equal to their mothers, before accumulating additional contaminant loads during life and passing higher loads to the next generation (Gauthier et al. 1997; Metcalfe et al. 2004). This is supported by ear plug data showing maternal transfer of pesticides and flame retardants in the first year of life (Trumble et al. 2013). These data also support pulses of mercury in body tissues of the male studied (Trumble et al. 2013).

4.2.1.11 ***Critical Habitat***

The NMFS has not designated critical habitat for blue whales.

4.2.2 Fin Whale

The fin whale, *Balaenoptera physalus* (Linnæus 1758), is a cosmopolitan species of baleen whale (Gambell 1985a). Fin whales are the second-largest whale species by length. Fin whales are long-bodied and slender, with a prominent dorsal fin set about two-thirds of the way back on the body. The streamlined appearance can change during feeding when the pleated throat and chest area becomes distended by the influx of prey and seawater, giving the animal a tadpole-like appearance. The basic body color of the fin whale is dark gray dorsally and white ventrally, but the pigmentation pattern is complex. The lower jaw is gray or black on the left side and creamy white on the right side. This asymmetrical coloration extends to the baleen plates as well, and is reversed on the tongue. Individually distinctive features of pigmentation, along with dorsal fin shapes and body scars, have been used in photo-identification studies (Agler et al. 1990). Fin whales can be found in social groups of 2 to 7 whales. Aguilar and Lockyer (1987) suggested annual natural mortality rates in northeast Atlantic fin whales may range from 0.04 to 0.06. This is supported by an estimated annual survival rate of 0.955 for Gulf of St. Lawrence fin whales (Ramp et al. 2014). Fin whales live 70 to 80 years Kjeld et al. (2006).

4.2.2.1 ***Distribution***

Fin whales are distributed widely in every ocean except the Arctic Ocean. Fin whales undertake migrations from low-latitude winter grounds to high-latitude summer grounds and extensive longitudinal movements both within and between years (Mizroch et al. 1999). Fin whales are sparsely distributed during November through April, from 60° N, south to the northern edge of the tropics, where mating and calving may take place (Mizroch et al. 1999). However, fin whales have been sighted as far as 60° N throughout winter (Mizroch et al. 1999).

Fin whales are observed year-round off central and southern California with peak numbers in the summer and fall (Barlow 1997; Campbell et al. 2015; Dohl et al. 1983; Forney et al. 1995). Peak numbers are seen during the summer off Oregon, and in summer and fall in the Gulf of Alaska and southeastern Bering Sea (Moore et al. 2000; Perry et al. 1999). Fin whales are observed feeding in Hawaiian waters during mid-May, and their sounds have been recorded there during the autumn and winter (Balcomb 1987; Northrop et al. 1968; Shallenberger 1981; Thompson and Friedl 1982). They have been recorded at Nihoa and other areas of the NWHI in the winter and spring months (Meigs et al. 2013). Fin whales in the western Pacific winter in the Sea of Japan, the East China, Yellow, and Philippine seas (Gambell 1985a).

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

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

4.2.2.2 ***Population Structure***

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

In the North Pacific Ocean, the International Whaling Commission recognizes two “stocks”: (1) East China Sea and (2) rest of the North Pacific (Donovan 1991). However, Mizroch et al. (1984a) concluded that there were five possible “stocks” of fin whales within the North Pacific based on histological analyses and tagging experiments: (1) East and West Pacific that intermingle around the Aleutian Islands; (2) East China Sea; (3) British Columbia; (4) Southern-

Central California to Gulf of Alaska; and (5) Gulf of California. Based on genetic analyses, Berube et al. (1998) concluded that fin whales in the Sea of Cortez represent an isolated population that has very little genetic exchange with other populations in the North Pacific Ocean (although the geographic distribution of this population and other populations can overlap seasonally). They also concluded that fin whales in the Gulf of St. Lawrence and Gulf of Maine are distinct from fin whales found off Spain and in the Mediterranean Sea.

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

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

4.2.2.3 ***Reproduction***

Fin whales reach sexual maturity between 5–15 years of age (COSEWIC 2005; Gambell 1985a; Lockyer 1972). Mating and calving occurs primarily from October-January, gestation lasts approximately 11 months, and nursing occurs for 6 to 11 months (Boyd et al. 1999; Hain et al. 1992). The average calving interval in the North Atlantic is estimated at about 2 to 3 years (Agler et al. 1993; Christensen et al. 1992). The location of winter breeding grounds is uncertain but mating is assumed to occur in pelagic mid-latitude waters (Perry et al. 1999). This was recently contradicted by acoustic surveys in the Davis Strait and off Greenland, where singing by fin whales peaked in November through December; the authors suggested that mating may occur prior to southbound migration (Simon et al. 2010). Although seasonal migration occurs between presumed foraging and breeding locations, fin whales have been acoustically detected throughout the North Atlantic Ocean and Mediterranean Sea year-round, implying that not all individuals follow a set migratory pattern (Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010). (Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010)(Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010)(Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010)(Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010)Reductions in pregnancy rates appear correlated with reduced blubber thickness and prey availability (Williams et al. 2013). Recent IWC scientific whaling data suggest that, compared to commercial whaling periods, preganancy rates have decreased, age at sexual maturity has increased, size growth is slowing, and males now compose a slightly higher proportion of the population than female (Gunnlaugsson et al. 2013).

4.2.2.4 ***Feeding***

In the North Pacific, fin whales also prefer euphausiids and large copepods, followed by schooling fish such as herring, walleye pollock, and capelin (Kawamura 1982a; Kawamura

1982b; Ladrón De Guevara et al. 2008; Nemoto 1970; Paloma et al. 2008). Fin whales frequently forage along cold eastern current boundaries (Perry et al. 1999). Feeding may occur in waters as shallow as 10 m when prey are at the surface, but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Gaskin 1972; Nature Conservancy Council 1979 as cited in ONR 2001; Panigada et al. 2008; Sergeant 1977).

4.2.2.5 ***Diving and Social Behavior***

The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5 to 20 shallow dives, each of 13 to 20 s duration, followed by a deep dive of 1.5 to 15 min (Gambell 1985a; Lafortuna et al. 2003; Stone et al. 1992). Other authors have reported that the fin whale's most common dives last 2 to 6 min (Hain et al. 1992; Watkins 1981a). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll et al. 2001a). However, Lafortuna et al. (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m are known (Panigada et al. 1999).

Fin whales tend to avoid tropical and pack-ice waters, with the high-latitude limit of their range set by ice and the lower-latitude limit by warm water of approximately 15° C (Sergeant 1977). Fin whale concentrations generally form along frontal boundary, or mixing zones between coastal and oceanic waters, which corresponds roughly to the 200 m isobath (the continental shelf edge) (Cotte et al. 2009; Nasu 1974).

4.2.2.6 ***Vocalization and Hearing***

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

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

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

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

Fin whales produce a variety of low frequency (< 1 kHz) sounds, but the most typically recorded is a 20 Hz pulse lasting about 1 second, and reaching source levels of 189 ± 4 dB re 1 μPam (Charif et al. 2002; Clark et al. 2002; Edds 1988; Richardson et al. 1995; Sirovic et al. 2007; Watkins 1981a; Watkins et al. 1987). These pulses frequently occur in long sequenced patterns, are down swept (e.g., 23 to 18 Hz), and can be repeated over the course of many hours (Watkins et al. 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 (Clarke and Charif 1998). The seasonality and stereotypic nature of these vocal sequences suggest that they are male reproductive displays (Watkins 1981a; Watkins et al. 1987); a notion further supported by recent data linking these vocalizations to male fin whales only (Croll et al. 2002). In Southern California, the 20 Hz pulses are the dominant fin whale call type associated both with call-counter-call between multiple animals and with singing (Navy 2010; Navy 2012). An additional fin whale sound, the 40 Hz call described by Watkins (1981b), was also frequently recorded, although these calls are not as common as the 20 Hz fin whale pulses. Seasonality of the 40 Hz calls differed from the 20 Hz calls, since 40 Hz calls were more prominent in the spring, as observed at other sites across the northeast Pacific (Sirovic et al. 2012). Source levels of Eastern Pacific fin whale 20-Hz calls has been reported as 189 +/- 5.8 dB re 1uPa at 1m (Weirathmueller et al. 2013). Although acoustic recordings of fin whales from many diverse regions show close adherence to the typical 20 Hz bandwidth and sequencing when performing these vocalizations, there have been slight differences in the pulse patterns, indicative of some geographic variation (Thompson et al. 1992; Watkins et al. 1987).

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

Although no studies have directly measured the sound sensitivity of fin whales, experts assume that fin whales are able to receive sound signals in roughly the same frequencies as the signals they produce. This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than at mid- to high-frequencies (Ketten 1997). Several fin whales were tagged during the Southern California-10 BRS and no obvious responses to a mid-frequency sound source were detected by the visual observers or in the initial tag analysis (Southall et al. 2011a). Results of studies on blue whales (Goldbogen et al. 2013) (Southall et al. 2011a), which have similar auditory physiology compared to fin whales, indicate that some individuals hear some sounds in the mid-frequency range and exhibit behavioral responses to sounds in this range depending on received level and context. In terms of functional hearing capability fin whales belong to the low-frequency group, which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007).

4.2.2.7 ***Status and Trends***

Fin whales were originally listed as endangered in 1970 (35 FR 18319), and this status has continued since the inception of the ESA in 1973. Although fin whale population structure remains unclear, various abundance estimates are available. Pre-exploitation fin whale abundance is estimated at 464,000 individuals worldwide; the estimate for 1991 was roughly 25 percent of this (Braham 1991). Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989). The most recent abundance estimates for fin whales that we are aware of are 16,625 individuals in the North Pacific Ocean and 119,000 individuals worldwide (Braham 1991). Fin whales of the north Pacific appear to be increasing in abundance although the trend is unclear or declining thoughout the rest of their range (NMFS 2011).

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

4.2.2.8 ***Natural Threats***

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggested annual natural mortality rates might range from 0.04 to 0.06 for northeast Atlantic fin whales. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure and may be preventing some fin whale populations from recovering (Lambertsen 1992). Adult fin whales engage in a flight responses (up to 40 km/h) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Shark attacks may also result in serious injury or death in very young and sick individuals (Perry et al. 1999).

4.2.2.9 ***Anthropogenic Threats***

Fin whales have undergone significant exploitation, but are currently protected under the IWC. Fin whales are still hunted in subsistence fisheries off West Greenland. In 2003, two males and four females were landed and two others were struck and lost (IWC 2005). In 2004, five males and six females were killed, and two other fin whales were struck and lost. Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery. However, the scientific recommendation was to limit the number killed to four individuals until accurate populations could be produced (IWC 2005). In the Antarctic Ocean, fin whales are hunted by Japanese whalers who have been allowed to kill up to 10 fin whales each year for the 2005 to 2006 and 2006 to 2007 seasons under an Antarctic Special Permit NMFS (2006c). Japanese whalers plan to kill 50 whales per year starting in the 2007 to 2008 season and continuing for the next 12 years (IWC 2006; Nishiwaki et al. 2006).

Fin whales experience injury and mortality from fishing gear and ship strikes (Carretta et al. 2007; Douglas et al. 2008; Lien 1994; Perkins and Beamish 1979; Waring et al. 2007). Between 1969 and 1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador; of these seven are known to have died because of capture (Lien 1994; Perkins and Beamish 1979). According to Waring et al. (2007), four fin whales in the western North Atlantic died or were seriously injured in fishing gear, while another five were killed or injured as a result of ship strikes between January 2000 and December 2004. Between 1999 and 2005, there were 15 reports of fin whales strikes by vessels along the U.S. and Canadian Atlantic coasts (Cole et al. 2005a; Nelson et al. 2007a). Of these, 13 were confirmed, resulting in the deaths of 11 individuals. Similarly, 2.4 percent of living fin whales from the Mediterranean show ship strike injury and 16 percent of stranded individuals were killed by vessel collision (Panigada et al. 2006). There are also numerous reports of ship strikes off the Atlantic coasts of France and England (Jensen and Silber 2004).

Management measures aimed at reducing the risk of ships hitting right whales should also reduce the risk of collisions with fin whales. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to be capable of reducing fin whale ship strike mortality by 27 percent in the Bay of Fundy region. Jensen and Silber's (2004) review of the NMFS' ship strike database revealed fin whales as the most frequently confirmed victims of ship strikes (26 percent of the recorded ship strikes [n = 75/292 records]), with most collisions occurring off the east coast, followed by the west coast of the U.S. and Alaska/Hawaii. Five of seven fin whales stranded along Washington State and Oregon showed evidence of ship strike with incidence increasing since 2002 (Douglas et al. 2008). From 1994 to 1998, two fin whales were presumed killed by ship strikes. More recently, in 2002, three fin whales were struck and killed by vessels in the eastern North Pacific (Jensen and Silber 2003).

The vast majority of ship strike mortalities are never identified, and actual mortality is higher than currently documented; however, it is Navy policy to report all ship strikes.

Increased noise in the ocean stemming from shipping seems to alter the acoustic patterns of singing fin whales, possibly hampering reproductive parameters across wide regions (Castellote et al. 2012).

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

4.2.2.10 *Critical Habitat*

The NMFS has not designated critical habitat for fin whales.

4.2.3 Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are distinguished from other whales in the same Family (Balaenopteridae) by extraordinarily long flippers (up to 5 m or about 1/3 total body length), a more robust body, fewer throat grooves (14 to 35), more variable dorsal fin, and utilization of very long (up to 30 min.), complex, repetitive vocalizations (songs) (Payne and McVay 1971) during courtship. Their grayish-black baleen plates, approximately 270 to 440 on each side of the jaw, are intermediate in length (6570 cm) to those of other baleen whales. Humpbacks in different geographical areas vary somewhat in body length, but maximum recorded size is 18m (Winn and Reichley 1985).

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

4.2.3.1 ***Distribution***

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

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

4.2.3.2 ***Population Structure***

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

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

Separate feeding groups of humpback whales are thought to inhabit western U.S. and Canadian waters, with the boundary between them located roughly at the U.S./Canadian border. The southern feeding ground ranges between 32° and 48° N, with limited interchange with areas north of Washington State (Calambokidis et al. 2004; Calambokidis et al. 1996). On April 21, 2015, NMFS proposed to divide the globally listed endangered humpback whale population into 14 DPSs (80 FR 22304). Ten of these DPS are not proposed for listing under the ESA while two are proposed as endangered and two are proposed as threatened. The humpback whales in the Action Area may belong to the proposed threatened Western North Pacific DPS, or to the Hawaii or Mexico DPSs which, as proposed, would not be listed under the ESA.

4.2.3.3 ***Reproduction and Growth***

Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to 1 year (Baraff and Weinrich 1993). Sexual maturity is reached at between 5 to 7 years of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years (e.g., southeast Alaska, Gabriele et al. 2007). Females usually breed every 2 to 3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987; 1990; Glockner-Ferrari and Ferrari 1985 as cited in NMFS 2005b; Weinrich et al. 1993). Males appear to return to breeding grounds more frequently than do females (Herman et al. 2011). Larger females tend to produce larger calves that may have a greater chance of survival (Pack et al. 2009). Females appear to preferentially select larger-sized males (Pack et al. 2012). In some Atlantic areas, females tend to prefer shallow nearshore waters for calving and rearing, even when these areas are extensively trafficked by humans (Picanco et al. 2009). Offspring appear to return to the same breeding areas at which they were born one they are independent (Baker et al. 2013).

In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry et al. 1999). Males court females in escort groups and compete for proximity and presumably access to reproduce females (particularly larger females)(Pack et al. 2009). Although long-term relationships do not appear to exist between males and females, mature females do pair with other females; those individuals with the longest standing relationships also have the highest reproductive output, possibly as a result of improved feeding cooperation (Ramp et al. 2010). Site fidelity off Brazilian breeding grounds was extremely low, both within and between years (Baracho-Neto et al. 2012).

Generation time for humpback whales is estimated at 21.5 years, with individuals surviving from 80-100 years (COSEWIC 2011).

4.2.3.4 ***Feeding***

During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Hain et al. 1982; Hain et al. 1995; Jurasz and Jurasz 1979; Weinrich et al. 1992a; Witteveen et al. 2011). The principal fish prey in the western North Atlantic are sand lance, herring, and capelin (Kenney et al. 1985). There is good evidence of some territoriality on feeding and calving areas (Clapham 1994; Clapham 1996; Tyack 1981). Humpback whales are generally believed to fast while migrating and on breeding grounds, but some individuals apparently feed while in low-latitude waters normally believed to be used exclusively for reproduction and calf-rearing (Danilewicz et al. 2009; Pinto De Sa Alves et al. 2009). Some individuals, such as juveniles, may not undertake migrations at all (Findlay and Best. 1995). Additional evidence, such as songs sung in northern latitudes during winter, provide additional support to plastic seasonal distribution (Smith and G.Pike 2009). Relatively high rates of resighting in foraging sites in suggest whales return to the same areas year after year (Ashe et al. 2013; Kragh Boye et al. 2010). This trend appears to be maternally linked, with offspring returning to the same areas their mother brought them once calves are independent (Baker et al. 2013; Barendse et al. 2013). Humpback whales in foraging areas may forage largely or exclusively at night when prey are closer to the surface while in foraging areas (Friedlaender et al. 2013). Humpback whales primarily feed along the shelf break and continental slope (Green et al. 1992; Tynan et al. 2005).

4.2.3.5 ***Diving and Social Behavior***

In Hawaiian waters, humpback whales remain almost exclusively within the 1,800 m isobath and usually within water depths of less than 182 m. Maximum diving depths are approximately 170 m (but usually <60 m), with a very deep dive (240 m) recorded off Bermuda (Hamilton et al. 1997). Dives can last for up to 21 min, although feeding dives ranged from 2.1 to 5.1 min in the North Atlantic (Dolphin 1987). In southeast Alaska, average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California, humpback whale dive durations averaged 3.5 min (Strong 1990). Because most humpback prey is likely found within 300 m of the surface, most humpback dives are probably relatively shallow. In Alaska, capelin are the primary prey of humpback and are found primarily between 92 and 120 m; depths to which humpbacks apparently dive for foraging (Witteveen et al. 2008).

Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months (where they feed; (Gendron and Urban 1993). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985). Humpback whales wintering in the West Indies migrate relatively directly to the Gulf of Maine and areas around Iceland and Norway (Kennedy et al. 2013). Some individuals may not migrate, or species occurrence in foraging areas may extend beyond summer months (Van Opzeeland et al. 2013). Average group size near Kodiak Island is 2 to 4 individuals, although larger groups are seen near Shuyak and Sitkalidak islands and groups of 20 or more have been documented (Wynne et al. 2005).

4.2.3.6 *Vocalization and Hearing*

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144 to 174 dB (Au et al. 2006b; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995; Winn et al. 1970). Males also produce sounds associated with aggression, which are generally characterized as frequencies between 50 Hz to 10 kHz and having most energy below 3 kHz (Silber 1986; Tyack 1983). Such sounds can be heard up to 9 km away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995; Tyack 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25 to 89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175 to 192 dB re 1 μPa at 1 m) (Au et al. 2000b; Erbe 2002a; Payne 1985; Richardson et al. 1995; Thompson et al. 1986). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995).

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

Social calls range from 20 Hz to 10 kHz, with dominant frequencies below 3 kHz (D'Vincent et al. 1985; Dunlop et al. 2008; Silber 1986; Simao and Moreira 2005). Female vocalizations appear to be simple; 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 Hz to 2 kHz, less than 1 second in duration, and have source levels of 162 to 192 dB re 1 μPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985) (D’Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic has been documented with Digital Acoustic Recording Tags (DTAGs[4]) (Stimpert et al. 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple bouts of broadband click trains that were acoustically different from toothed whale echolocation: Stimpert et al. (Stimpert et al. 2007) termed these sounds “mega-clicks” which showed relatively low received levels at the DTAGs (143 to 154 dB re 1 μPa), with the majority of acoustic energy below 2 kHz.

Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz (Ketten and Mountain 2014). Previously mentioned research by Au et al. (2001) and Au et al. (2006b) off Hawaii indicated the presence of high-frequency harmonics in vocalizations up to and beyond 24 kHz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpbacks to hear frequencies around 3 kHz may have been demonstrated

---

[4] DTAG is a novel archival tag, developed to monitor the behavior of marine mammals, and their response to sound, continuously throughout the dive cycle. The tag contains a large array of solid-state memory and records continuously from a built-in hydrophone and suite of sensors. The sensors sample the orientation of the animal in three dimensions with sufficient speed and resolution to capture individual fluke strokes. Audio and sensor recording is synchronous so the relative timing of sounds and motion can be determined precisely Johnson, M. P., and P. L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE Journal of Oceanic Engineering 28(1):3-12..

in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kHz at 219 dB re 1µPa-m or frequency sweep of 3.1 kHz to 3.6 kHz (although it should be noted that this system is significantly different from the Navy's hull mounted sonar). In addition, the system had some low frequency components (below 1 kHz) which may have been an artifact of the acoustic equipment. This possible artefact may have affected the response of the whales to both the control and sonar playback conditions.

Results of studies on blue whales (Goldbogen et al. 2013) (Southall et al. 2011a), which have similar auditory physiology compared to humpback whales, indicate that some individuals hear some sounds in the mid-frequency range and exhibit behavioral responses to sounds in this range depending on received level and context. In terms of functional hearing capability humpback whales belong to low-frequency cetaceans which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007).

4.2.3.7 ***Status and Trends***

Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status remains under the ESA. On April 21, 2015, NMFS proposed to divide the globally listed endangered humpback whale population into 14 DPSs (80 FR 22304). The humpback whales in the Action Area may belong to the proposed threatened Western North Pacific DPS, or to the Hawaii or Mexico DPSs which, as proposed, would not be listed under the ESA.

It is estimated that 15,000 humpback whales resided in the North Pacific in 1905 (Rice 1978a). However, from 1905 to 1965, nearly 28,000 humpback whales were harvested in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry et al. 1999). The overall abundance of humpback whales in the north Pacific was recently estimated at 21,808 individuals (coefficient of variation = 0.04), confirming that this population of humpback whales has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al. 2011). Data indicates the North Pacific population has been increasing at a rate of between 5.5 percent and 6.0 percent per year, therefore approximately doubling every 10 years (Calambokidis et al. 2008).

Modeled abundance increase in southeastern Alaska was 5.1 percent annually from 1986 to 2008 (Hendrix et al. 2012); a more specific estimate from Glacier Bay, the site of a long-term monitoring study over roughly the same time frame found a rate of increase of 4.4 percent (Saracco et al. 2013). For Asia, an annual rate of growth of 6.7 percent has been estimated (Calambokidis et al. 2008).

In the Pacific, the stock structure of humpback whales is defined based on feeding areas because of the species' fidelity to feeding grounds (Carretta et al. 2010). The NMFS has designated four stocks for management purposes under the MMPA: (1) the Central North Pacific stock, with feeding areas from Southeast Alaska to the Alaska Peninsula; (2) the Western North Pacific stock, with feeding areas from the Aleutian Islands, Bering Sea, and Russia; (3) the California, Oregon, Washington, and Mexico stock, with feeding areas off the U.S. west coast; and (4) the American Samoa stock, with feeding areas as far south as the Antarctic Peninsula (Allen and Angliss 2010b).

4.2.3.8 ***Natural Threats***

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

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (Perry et al. 1999). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period. One-quarter of humpback whales of the Arabian Sea population show signs of tattoo skin disease, which may reduce the fitness of afflicted individuals (Baldwin et al. 2010). Emaciated calf and juvenile humpbacks were found in numbers an order of magnitude higher than normal along Western Australia in 2009 due to unknown causes (Coughran et al. 2013).

4.2.3.9 ***Anthropogenic Threats***

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

Humpback whales are also killed or injured during interactions with commercial fishing gear. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Lien 1994; Perkins and Beamish 1979). From 1979 through 2008, 1,209 whales were recorded entangled, 80 percent of which were humpback whales (Benjamins et al. 2012). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005b; Nelson et al. 2007b). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dying of their wounds. Along the Pacific coast of Canada, 40 humpback whales have been reported as entangled since 1980, four of which are known to have died (COSEWIC 2011; Ford et al. 2009).

Between 30 and 40 percent of humpback whales in the Arabian Sea show scarring from entanglements, with fishing effort on the rise (Baldwin et al. 2010). Alava et al. (2012) reported that 0.53 percent of humpback whale populations breeding along Ecuador are bycaught annually in commercial fishing gear (mortality of 15 to 33 individuals per year). From 2004 to 2008, 18 humpback whales were observed to be entangled along the U.S. west coast, of which 14 were considered seriously injured and two are known to have died (Carretta et al. 2013b). From 2006 to 2010, 29 entangled whales were identified with serious injury or mortality resulting from the entanglement (Waring et al. 2013). From 1996 to 2000, 22 humpback whales of the Central North Pacific population were found entangled in fishing gear (Angliss and Lodge 2004). In 1996, a vessel from the Navy Pacific Missile Range Facility in Hawaii rescued an entangled humpback, removing two crabpot floats from the whale. A photography study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53 percent of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005). There are also reports of entangled humpback whales from the Hawaiian Islands. In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill et al. 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. From 2001 through 2006, there were 23 reports of entangled humpback whales in Hawaiian waters; 16 of these reports were from 2005 and 2006. A photography study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53 percent of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005). Between 30 and 40 percent of humpback whales in the Arabian Sea show scarring from entanglements, with fishing effort on the rise (Baldwin et al. 2010). Alava et al. (2012) reported that 0.53 percent of humpback whale populations breeding along Ecuador are bycaught annually in commercial fishing gear (mortality of 15 to 33 individuals per year). Ten humpback whales were found entangled in gill nets or long lines between 1995 and 2002 off Peru (Garcia-Godos et al. 2013).

Many of the entangled humpback whales observed in Hawaiian waters brought the gear with them from higher latitude feeding grounds; for example, the whale the U.S. Navy rescued in 1996 had been entangled in gear that was traced to a recreational fisherman in southeast Alaska. Thus far, 6 of the entangled humpback whales observed in the Hawaiian Islands have been confirmed to have been entangled in gear from Alaska. Nevertheless, humpback whales are also entangled in fishing gear in the Hawaiian Islands. Since 2001, there have been 5 observed interactions between humpback whales and gear associated with the Hawaii-based longline fisheries (NMFS 2008). In each instance, however, all of the whales were disentangled and released or they were able to break free from the gear without reports of impairment of the animal’s ability to swim or feed.

More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1 percent) showed evidence of collisions with ships (Laist et al. 2001). From 1975 through 2011, 68 collisions were actually witnessed in the main Hawaiian Islands, 63 percent involving calves and subadults, with the rate of collisions increasing over time even accounting for higher numbers of whales present (Lammers et al. 2013). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005b; Nelson et al. 2007b). Of these reports, 13 were confirmed as ship strikes and in seven cases, ship strike was determined to be the cause of death. Along Pacific Canada, 21q reports of ship strikes involving humpback whales were reported from 2001 to 2008 (COSEWIC 2011; Ford et al. 2009). From 2006 to 2010, 10 instances of mortality stemming from vessel collision were documented (Waring et al. 2013). In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9 percent. The first estimate of population-level effects of entanglement were recently produced, with over 12 percent of the Gulf of Maine population of humpbacks acquiring new scars from entanglement interactions annually (Mattila and Rowles 2010). Two humpbacks were recorded as ships truck and died along the west coast from 2004 to 2008; a third was known to have been struck but its outcome is unknown (Carretta et al. 2013b). On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). The humpback whale calf that was found stranded on Oahu with evidence of vessel collision (propeller cuts) in 1996 suggests that ship collisions might kill adults, juvenile, and calves (NMFS unpublished data). Although data for actual strikes is lacking off Pacific Panama, study of shipping data and satellite tag data on humpback whales showed that 8 of 15 whales tagged came within 200 m of 81 different ships on 98 occasions in a period of 11 days (Guzman et al. 2013).

Organochlorines, including PCB and DDT, have been identified from humpback whale blubber (Gauthier et al. 1997). Higher PCB levels have been observed in western Atlantic waters versus Pacific waters along the United States and levels tend to increase with individual age (Elfes et al. 2010); eastern Atlantic individuals fall between these two in contaminant burden (Ryan et al. 2014). Although humpback whales in the Gulf of Maine and off Southern California tend to have the highest PCB concentrations, overall levels are on par with other baleen whales, which are generally lower than odontocete cetaceans (Elfes et al. 2010). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of mothers before bioaccumulating additional contaminants during life and passing the additional burden to the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

4.2.3.10 *Critical Habitat*

The NMFS has not designated critical habitat for humpback whales.

4.2.4 North Pacific right whale

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

4.2.4.1 *Distribution*

Very little is known of the distribution of right whales in the North Pacific and very few of these animals have been seen in the past 20 years. Historical whaling records indicate that right whales ranged across the North Pacific north of 30° N latitude and occasionally as far south as 20° N, with a bimodal distribution longitudinally favoring the eastern and western North Pacific and occurring infrequently in the central North Pacific (Gregr and Coyle. 2009; Josephson et al. 2008; Maury 1853; Scarff 1986; Scarff 1991; Townsend 1935). North Pacific right whales summered in the North Pacific and southern Bering Sea from April or May to September, with a peak in sightings in coastal waters of Alaska in June and July (Klumov 1962; Maury 1852; Omura 1958; Omura et al. 1969; Townsend 1935). North Pacific right whale summer range extended north of the Bering Strait (Omura et al. 1969). However, they were particularly abundant in the Gulf of Alaska from 145° to 151°W, and apparently concentrated in the Gulf of Alaska, especially south of Kodiak Islands and in eastern Aleutian Islands and southern Bering Sea waters (Berzin and Rovnin 1966; Braham and Rice 1984).

Current information on the seasonal distribution of right whales is spotty. In the eastern North Pacific, this includes sightings over the middle shelf of the Bering Sea, Bristol Bay, Aleutian and Pribilof Islands (Goddard and Rugh 1998; Hill and Demaster 1998; Perryman et al. 1999; Waite et al. 2003). Some more southerly records also record occurrence along Hawaii, California, Washington, and British Columbia (Herman et al. 1980; Scarff 1986). However, records from Mexico and California may suggest historical wintering grounds in offshore southern North Pacific latitudes (Brownell Jr. et al. 2001; Gregr and Coyle. 2009).

Habitat preference data are sparse for North Pacific right whales as well. Sightings have been made with greater regularity in the western North Pacific, notably in the Okhotsk Sea, Kuril Islands, and adjacent areas (Brownell Jr. et al. 2001). In the western North Pacific, feeding areas occur in the Okhotsk Sea and adjacent waters along the coasts of Kamchatka and the Kuril Islands (IWC 2001).

Historical concentrations of sightings in the Bering Sea together with some recent sightings indicate that this region, together with the Gulf of Alaska, may represent an important summer habitat for eastern North Pacific right whales (Brownell Jr. et al. 2001; Clapham et al. 2004a; Goddard and Rugh 1998; Scarff 1986; Shelden et al. 2005). North Pacific right whale occurrence in the Bering Sea during summer appears to be strongly influenced by the occurrence and abundance of the copepod *Calanus marshallae* (Baumgartner et al. 2013). Few sighting data are available from the eastern North Pacific, with a single sighting of 17 individuals in the southeast Bering Sea being by far the greatest known occurrence (Wade et al. 2006). Some further sightings have occurred in the northern Gulf of Alaska (Wade et al. 2006). Recent eastern sightings tend to occur over the continental shelf, although acoustic monitoring has identified whales over abyssal waters (Mellinger et al. 2004b). It has been suggested that North Pacific right whales have shifted their preferred habitat as a result of reduced population numbers, with oceanic habitat taking on a far smaller component compared to shelf and slope waters (Shelden et al. 2005). The area where North Pacific right whales are densest in the Gulf of Alaska is between 150 and 170° W and south to 52° N (Shelden and Clapham 2006), but present occurrence there is very rare (Wade et al. 2011b). However, four sightings were made from 2004-2006 off Kodiak Island in association with high zooplankton concentrations (Wade et al. 2011b). A right whale was sighted southeast of Kodiak Island in July 1998 and acoustic detections have been made off Kodiak Island, although no detections occurred from April to August 2003 or in April 2009 (Munger et al. 2008; Rone et al. 2010; Waite et al. 2003). The greatest frequency of call occurrence in the southeastern Bering Sea occurs from July to October (Munger et al. 2008).

Historical sighting and catch records provide the only information on possible migration patterns for North Pacific right whales (Omura 1958; Omura et al. 1969; Scarff 1986). During summer, whales have been found in the Gulf of Alaska, along both coasts of the Kamchatka Peninsula, the Kuril Islands, the Aleutian Islands, the southeastern Bering Sea, and in the Okhotsk Sea. Fall and spring distribution was the most widely dispersed, with whales occurring in mid-ocean waters and extending from the Sea of Japan to the eastern Bering Sea. In winter, right whales have been found in the Ryukyu Islands (south of Kyushu, Japan), the Bonin Islands, the Yellow Sea, and the Sea of Japan. Whalers never reported winter calving areas in the North Pacific and where calving occurs remains unknown (Clapham et al. 2004a; Gregr and Coyle. 2009; Scarff 1986). North Pacific right whales probably migrate north from lower latitudes in spring and may occur throughout the North Pacific from May through August north of 40º N from marginal seas to the Gulf of Alaska and Bering Sea, although absence from the central North Pacific has been argued due to inconsistencies in whaling records (Clapham et al. 2004b; Josephson et al. 2008). This follows generalized patterns of migration from high-latitude feeding grounds in summer to more temperate, possibly offshore waters, during winter (Braham and Rice 1984; Clapham et al. 2004a; Scarff 1986).

4.2.4.2 ***Population structure***

All North Pacific right whales constitute a single population, although debate exists about subdivisions (Kennedy et al. 2012; Leduc et al. 2012).

4.2.4.3 ***Reproduction and growth***

While no reproductive data are known for the North Pacific, studies of North Atlantic right whales suggest calving intervals of two to seven years and growth rates that are likely dependent on feeding success (Best et al. 2001; Burnell 2001; Cooke et al. 2001; Kenney 2002; Knowlton et al. 1994; Reynolds et al. 2002). It is presumed that right whales calve during mid-winter (Clapham et al. 2004a). Lifespans of up to 70 years can be expected based upon North Atlantic right whale data.

4.2.4.4 ***Feeding***

Stomach contents from North Pacific right whales indicate copepods and, to a lesser extent, euphausiid crustaceans are the whales' primary prey (Omura et al. 1969). North Pacific right whales have also been observed feeding on coccolithophore blooms (Tynan et al. 2001). Their diet is likely more varied than North Atlantic right whales, likely due to the multiple blooms of different prey available in the North Pacific from January through August (Gregr and Coyle. 2009). Based upon trends in prey blooms, it is predicted that North Pacific right whales may shift from feeding offshore to over the shelf edge during late summer and fall (Gregr and Coyle. 2009). North Pacific right whales, due to the larger size of North Pacific copepods, have been proposed to be capable to exploit younger age classes of prey as well as a greater variety of species. Also as a result, they may require prey densities that are one-half to one-third those of North Atlantic right whales (Gregr and Coyle. 2009). Right whales feed by continuously filtering prey through their baleen while moving, mouth agape, through patches of planktonic crustaceans. Right whales are believed to rely on a combination of experience, matrilinear learning, and sensing of oceanographic conditions to locate prey concentrations in the open ocean (Gregr and Coyle. 2009; Kenney 2001).

4.2.4.5 ***Vocalization and hearing***

Right whales vocalize to communicate over long distances and for social interaction, including communication apparently informing others of prey path presence (Biedron 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 300-600 Hz range with up- and down sweeping modulations (Vanderlaan et al. 2003). Vocalizations below 200 Hz and above 900 Hz were rare (Vanderlaan et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks et al. 2012a). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Up calls are 100-400 Hz (Gillespie and Leaper 2001). Gunshots appear to be a largely or exclusively male vocalization (Parks et al. 2005b). Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001). Moans are usually produced within 10 m of the surface (Matthews et al. 2001). Up calls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline 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 et al. 2011; Morano et al. 2012; Mussoline et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 dB re 1 μPa p-p (Hotchkin 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 et al. 2003; Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137-162 dB rms re: 1 μPa-m, except for gunshots, which are 174-192 dB rms re: 1 μPa-m (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). 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 and Clark 2007; Parks et al. 2005a; Parks et al. 2007a; Parks et al. 2011; Parks et al. 2010; Parks et al. 2012b; Parks et al. 2006), particularly the peak frequency (Parks et al. 2009). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek et al. 2003; Nowacek et al. 2004).

No direct measurements of right whale hearing have been undertaken (Parks and Clark 2007). Models based upon right whale auditory anatomy suggest a hearing range of 10 Hz to 22 kHz (Parks et al. 2007b).

4.2.4.6 ***Status and trends***

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

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

Very little is known about right whales in the eastern North Pacific, which were severely depleted by commercial whaling in the 1800s (Brownell Jr. et al. 2001). At least 11,500 individuals were taken by American whalers in the early- to mid-19th century, but harvesting continued into the 20th century (Best 1987). Illegal Soviet whaling took 661 individuals between 1962 and 1968, with 529 from the eastern North Pacific and 152 from the Okhotsk Sea, mostly of large mature individuals (Brownell Jr. et al. 2001; Ivashchenko and Clapham 2012; Ivashchenko et al. 2013). In the last several decades there have been markedly fewer sightings due to a drastic reduction in number, caused by illegal Soviet whaling in the 1960s (Doroshenko 2000). The current population size of right whales in the North Pacific is likely fewer than 1,000 animals compared to possibly 11,000 individuals or more prior to exploitation (NMFS 1991b; NMFS 2006f). Based upon mark-recapture estimates of abundance suggested right whales in the Bering Sea and Aleutian Islands numbered 31 individuals (95% CL 23-54, CV=0.22) and 28 (95% CL 24-42), respectively and composed of eight females and 20 males(Wade et al. 2011b).

Abundance estimates and other vital rate indices in both the eastern and western North Pacific are not well established. Where such estimates exist, they have very wide confidence limits. Previous estimates of the size of the right whale population in the Pacific Ocean range from a low of 100-200 to a high of 220-500 (Berzin and Yablokov 1978; Braham and Rice 1984). Although Hill and Demaster (1998) argued that it is not possible to reliably estimate the population size or trends of right whales in the North Pacific, Reeves et al. (2003) and Brownell Jr. et al. (2001) concluded that North Pacific right whales in the eastern Pacific Ocean exist as a small population of individuals while the western population of right whales probably consists of several hundred animals, although Clapham et al. (2005) placed this population at likely under 100 individuals Wade et al. (2011a) estimated 25-38 individuals). Brownell Jr. et al. (2001) reviewed sighting records and also estimated that the abundance of right whales in the western North Pacific was likely in the low hundreds. From 2007-2010, 12 individuals were observed in the southeastern Bering Sea (some on multiple occasions) (Allen and Angliss 2013). Genetic analyses indicate genetic diversity to be low, but not as low as North Atlantic right whales (Leduc et al. 2012), and higher than what might be expected from such a small population (Slikas et al. 2013). However, genetic diversity in the next generation is expected to be severely reduced (Slikas et al. 2013).

Scientists participating in a recent study utilizing acoustic detection and satellite tracking identified 17 right whales (10 males and 7 females) in the Bering Sea, which is almost threefold the number seen in any previous year in the last four decades (Wade et al. 2006). These sightings increased the number of individual North Pacific right whales identified in the genetic catalog for the eastern Bering Sea to 23. Amidst the uncertainty of the eastern North Pacific right whale's future, the discovery of females and calves gives hope that this endangered population may still possess the capacity to recover (Wade et al. 2006). Available age composition of the North Pacific right whale population indicates most individuals are adults (Kenney 2002). Length measurements for two whales observed off California suggest at least one of these whales was not yet sexually mature and two calves have been observed in the Bering Sea (Carretta et al. 1994; Wade et al. 2006). However, to date, there is no evidence of reproductive success (i.e., young reared to independence) in the eastern North Pacific. No data are available for the western North Pacific.

4.2.4.7 *Natural threats*

Right whales have been subjects of killer whale attacks and, because of their robust size and slow swimming speed, tend to fight killer whales when confronted (Ford and Reeves 2008). Similarly, mortality or debilitation from disease and red tide events are not known, but have the potential to be significant problems in the recovery of right whales because of their small population size.

4.2.4.8 *Anthropogenic threats*

Whaling for North Pacific right whales was discontinued in 1966 with the IWC whaling moratorium. However, North Pacific right whales remain at high risk of extinction. Demographic stressors include but are not limited to the following: (1) life history characteristics such as slow growth rate, long calving intervals, and longevity; (2) distorted age structure of the population and reduced reproductive success; (3) strong depensatory or Allee effects; (4) habitat specificity or site fidelity; and (5) habitat sensitivity. The proximity of the other known right whale habitats to shipping lanes (e.g. Unimak Pass) suggests that collisions with vessels may also represent a threat to North Pacific right whales (Elvin and Hogart 2008).

Climate change may have a dramatic effect on survival of North Pacific right whales. Right whale life history characteristics make them very slow to adapt to rapid changes in their habitat (see Reynolds et al. 2002). They are also feeding specialists that require exceptionally high densities of their prey (e.g., Baumgartner and Mate 2003). Zooplankton abundance and density in the Bering Sea has been shown to be highly variable, affected by climate, weather, and ocean processes and in particular ice extent (Baier and Napp 2003; Napp and G.L. Hunt 2001). The largest concentrations of copepods occurred in years with the greatest southern extent of sea ice (Baier and Napp 2003). It is possible that changes in ice extent, density, and persistence may alter the dynamics of the Bering Sea shelf zooplankton community and in turn affect the foraging behavior and success of right whales. No data are available for the western North Pacific.

4.2.4.9 *Critical Habitat*

North Pacific right whale critical habitat is considered in Section 4.1.5.2.

4.2.5 Sei Whale

Sei whales (pronounced "say" or "sigh"; *Balaenoptera borealis*) are members of the baleen whale family and are considered one of the "great whales" or rorquals. Two subspecies of sei whales are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. These large animals can reach lengths of 40 to 60 ft (12 to 18 m) and weigh 100,000 lbs (45,000 kg). Females may be slightly longer than males. Sei whales have a long, sleek body that is dark bluish-gray to black in color and pale underneath. The body is often covered in oval-shaped scars (probably caused from cookie-cutter shark and lamprey bites) and sometimes has subtle "mottling".

The Sei is regarded as the fastest swimmer among the great whales, reaching bursts of speed in excess of 20 knots. When a sei whale begins a dive it usually submerges by sinking quietly below the surface, often remaining only a few meters deep, leaving a series of swirls or tracks as it move its flukes. When at the water's surface, sei whales can be sighted by a columnar or bushy blow that is about 10 to 13 feet (3 to 4 m) in height. The dorsal fin usually appears at the same time as the blowhole, when the animal surfaces to breathe. This species usually does not arch its back or raise its flukes when diving.

Sei whales become sexually mature at 6 to 12 years of age when they reach about 45 ft (13 m) in length, and generally mate and give birth during the winter in lower latitudes. Females breed every 2 to 3 years, with a gestation period of 11 to 13 months. Females give birth to a single calf that is about 15 ft (4.6 m) long and weighs about 1,500 lbs (680 kg). Calves are usually nursed for 6 to 9 months before being weaned on the preferred feeding grounds. Sei whales have an estimated lifespan of 50 to 70 years.

4.2.5.1 ***Distribution***

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

In the North Pacific Ocean, sei whales occur from the Bering Sea south to California (on the east) and the coasts of Japan and Korea (on the west). During the winter, sei whales are found from 20° to 23°N (Gambell 1985b; Masaki 1977b). Sasaki et al. (2013) demonstrated that sei whale in the North Pacific are strongly correlated with sea surface temperatures between 13.1 and 16.8 degrees C. Sei whales have been seen in monitoring efforts in Hawaii in 2007 and in 2010.

4.2.5.2 ***Population Structure***

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

Mark-recapture, catch distribution, and morphological research indicate more than one population may exist in the North Pacific – one between 155° and 175° W, and another east of 155° W (Masaki 1976; Masaki 1977b). Sei whales have been reported primarily south of the Aleutian Islands, in Shelikof Strait and waters surrounding Kodiak Island, in the Gulf of Alaska, and inside waters of southeast Alaska and south to California to the east and Japan and Korea to the west (Leatherwood et al. 1982; Nasu 1974). Sightings have also occurred in Hawaiian waters. In Navy-funded surveys 2007 through 2012, there were three confirmed sighting of sei whales for a total of five individuals—all made from vessels (HDR 2012). Two sightings were documented northeast of Oahu in 2007 (Smultea et al. 2007), while the third was encountered near Perret Seamount west of the Island of Hawaii in 2010 (HDR 2012). Bottom depths for the sei whale sightings were from 3,100 to 4,500 m. Sightings were made during BSS 2-4. Smultea et al. (2010) noted that the lack of sightings of sei whales in the Hawaiian Islands may be due to misidentification and/or poor sighting conditions. Sei whales have been occasionally reported from the Bering Sea and in low numbers on the central Bering Sea shelf (Hill and Demaster 1998). Whaling data suggest that sei whales do not venture north of about 55° N (Gregr et al. 2000). Harwood (1987) evaluated Japanese sighting data and concluded that sei whales rarely occur in the Bering Sea. Harwood (1987) reported that 75 to 85 percent of the North Pacific population resides east of 180°. Considering the many British Columbia whaling catches in the early to mid-1900s, sei whales have clearly utilized this area in the past (Gregr et al. 2000; Pike and Macaskie 1969). Masaki (1977a) reported sei whales concentrating in the northern and western Bering Sea from July through September, although other researchers question these observations because no other surveys have reported sei whales in the northern and western Bering Sea.

Sei whales appear to prefer to forage in regions of steep bathymetric relief, such as continental shelf breaks, canyons, or basins situated between banks and ledges (Best and Lockyer 2002; Gregr and Trites 2001; Kenney and Winn 1987), where local hydrographic features appear to help concentrate zooplankton, especially copepods. In their foraging areas, sei whales appear to associate with oceanic frontal systems (Horwood 1987). In the north Pacific, sei whales are found feeding particularly along the cold eastern currents (Perry et al. 1999). Masaki (1977a) presented sightings data on sei whales in the North Pacific from the mid-1960s to the early 1970s. Over that time interval sei whales did not appear to occur in waters of Washington State and southern British Columbia in May or June, their densities increased in those waters in July and August (1.9 to 2.4 and 0.7 to 0.9 whales per 100 miles of distance for July and August, respectively), then declined again in September. More recently, sei whales have become known for an irruptive migratory habit in which they appear in an area then disappear for time periods that can extend to decades.).

4.2.5.3 *Reproduction*

Very little is known regarding sei whale reproduction. Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months, calves are weaned at 6–9 months, and the calving interval is about 2–3 years (Gambell 1985b; Rice 1977). Sei whales become sexually mature at about age 10 (Rice 1977). Of 32 adult female sei whales harvested by Japanese whalers, 28 were found to be pregnant while one was pregnant and lactating during May–July 2009 cruises in the western North Pacific (Tamura et al. 2009).

4.2.5.4 ***Movement***

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

4.2.5.5 ***Feeding***

Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although they are also known to consume fish (Waring et al. 2006). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Konishi et al. 2009; Mizroch et al. 1984b; Rice 1977). Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95 percent of their diets (Calkins 1986a). The dominant food for sei whales off California during June-August is northern anchovy, while in September-October whales feed primarily on krill (Rice 1977). The balance of their diet consists of squid and schooling fish, including smelt, sand lance, Arctic cod, rockfish, pollack, capelin, and Atka mackerel (Nemoto and Kawamura 1977). In the Southern Ocean, analysis of stomach contents indicates sei whales consume *Calanus* spp. and small-sized euphasiids with prey composition showing latitudinal trends (Kawamura 1974). Sei whales in the Southern Hemisphere may reduce direct interspecific competition with blue and fin whales by consuming a wider variety of prey and by arriving later to feeding grounds (Kirkwood 1992). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries. In the North Pacific, sei whales appear to prefer feeding along the cold eastern currents (Perry et al. 1999). Sei whales have the flexibility to skim or engulf prey (Brodie and Vikingsson 2009).

4.2.5.6 ***Diving and Social Behavior***

Generally, sei whales make 5 to 20 shallow dives of 20 to 30 second duration followed by a deep dive of up to 15 minutes (Gambell 1985b). The depths of sei whale dives have not been studied; however the composition of their diet suggests that they do not perform dives in excess of 300 meters. Sei whales are usually found in small groups of up to 6 individuals, but they commonly form larger groupings when they are on feeding grounds (Gambell 1985b).

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

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

4.2.5.7 *Vocalization and Hearing*

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

Recordings made in the presence of sei whales have shown that they produce sounds ranging from short, mid-frequency pulse sequences (Knowlton et al. 1991; Thompson et al. 1979) to low frequency broadband calls characteristic of mysticetes (Baumgartner et al. 2008; McDonald et al. 2005; Rankin and Barlow 2007). Off the coast of Nova Scotia, Canada, Knowlton et al. (1991) recorded two-phased calls lasting about 0.5 to 0.8 s and ranging in frequency from 1.5 kHz to 3.5 kHz in the presence of sei whales—data similar to that reported by Thompson et al. (1979). These mid-frequency calls are distinctly different from low-frequency tonal and frequency swept calls recorded in later studies. For example, calls recorded in the Antarctic averaged 0.45 ± 0.3 s in duration at 433 ± 192 Hz, with a maximum source level of 156 ± 3.6 dB re 1 μPa-m

(McDonald et al. 2005). During winter months off Hawaii, (Rankin and Barlow 2007)recorded down swept calls by sei whales that exhibited two distinct low frequency ranges of 100 Hz to 44 Hz and 39 Hz to 21 Hz, with the former range usually shorter in duration. Similar sei whale calls were also found near the Gulf of Maine in the northwest Atlantic, ranging from 82.3 Hz to 34.0 Hz and averaging 1.38 s in duration (Baumgartner et al. 2008). These calls were primarily single occurrences, but some double or triple calls were noted as well. It is thought that the difference in call frequency may be functional, with the mid-frequency type serving a reproductive purpose and the low frequency calls aiding in feeding/social communication (McDonald et al. 2005). Sei whales have also been shown to reduce their calling rates near the Gulf of Maine at night, presumably when feeding, and increase them during the day, likely for social activity (Baumgartner and Fratantoni 2008).

While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. Results of studies on blue whales (Goldbogen et al. 2013) (Southall et al. 2011a), which have similar auditory physiology compared to sei whales, indicate that some individuals hear some sounds in the mid-frequency range and exhibit behavioral responses to sounds in this range depending on received level and context. In terms of functional hearing capability, sei whales belong to low-frequency cetaceans which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007). There are no tests or modeling estimates of specific sei whale hearing ranges.

4.2.5.8 ***Status and Trends***

The sei whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973.

Ohsumi and Fukuda (1975) estimated that sei whales in the North Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000 to 38,000 whales by 1967, and reduced again to 20,600 to 23,700 whales by 1973. From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Horwood 1987; Perry et al. 1999). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300 to 600 sei whales were killed per year from 1911 to 1955. The sei whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei whale catch numbers, sei whales were scarce in Japanese waters. Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968 to 1969, after which the sei whale population declined rapidly (Mizroch et al. 1984b). This estimate does not account for over-reporting by Soviet whalers, who took approximately 3,700 fewer individuals than were reported (Ivashchenko et al. 2013). When commercial whaling for sei whales ended in 1974, the population in the North Pacific had been reduced to 7,260 to 12,620 animals (Tillman 1977). The most current population estimate for sei whales in the entire north Pacific is 9,110 (Calambokidis et al. 2008) and 25,000 individuals worldwide (Braham 1991).

NMFS has designated three stocks of sei whale for management purposes under the MMPA in the north Pacific: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al. 2011). Little is known about the stock structure of sei whales in the Action Area. Various scientists have described the seasonal distribution of sei whales as occurring from 20° N to 23° N during the winter and from 35° N to 50° N during the summer (Horwood 2009; Masaki 1976; Masaki 1977b; Smultea et al. 2010). No data on the current population trend are available; however, the population in the North Pacific is expected to have increased since sei whales began receiving protection in 1976 (Carretta et al. 2013a).

4.2.5.9 ***Natural Threats***

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

4.2.5.10 ***Anthropogenic Threats***

Human activities known to threaten sei whales include whaling, commercial fishing, and vessel strikes. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas. In 2009, 100 sei whales were killed during western North Pacific surveys (Bando et al. 2010).

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

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

4.2.5.11 ***Critical Habitat***

The NMFS has not designated critical habitat for sei whales.

4.2.6 Sperm Whale

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

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

4.2.6.1 ***Distribution***

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

4.2.6.2 ***Population Structure***

There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm et al. 1996; Lyrholm et al. 1999). Chemical analysis also suggests significant differences in diet for animals captured in different regions of the North Atlantic. However, vocal dialects indicate parent-offspring transmission that indicates differentiation in populations (Rendell et al. 2011). Vocal differences exist not only across ocean basins, but also over much smaller spatial scales (Amano et al. 2014). Therefore, population-level differences may be more extensive than are currently understood.

The IWC currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Dufault et al. 1999; Reeves and Whitehead 1997). The NMFS recognizes six stocks under the MMPA: three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii; (Perry et al. 1999; Waring et al. 2004). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003; Whitehead et al.

2008). Matrilinear groups in the eastern Pacific share nuclear DNA within broader clans, but North Atlantic matrilinear groups do not share this genetic heritage (Whitehead et al. 2012).

Sperm whales are found throughout the North Pacific and are distributed broadly in tropical and temperate waters to the Bering Sea as far north as Cape Navarin in summer, and occur south of 40^{o} N in winter (Gosho et al. 1984; Miyashita et al. 1995 as cited in Carretta et al. 2005; Rice 1974b). Sperm whales are found year-round in Californian and Hawaiian waters (Barlow 1995; Dohl et al. 1983; Forney et al. 1995; Lee 1993; Mobley Jr . et al. 2000; Rice 1960; Shallenberger 1981), but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974b; Rice 1974a). They are seen in every season except winter (December-February) off Washington and Oregon (Green et al. 1992). Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly towards the middle of the tropical Pacific and northward towards the tip of Baja California (Carretta et al. 2006). Sperm whales occupying the California Current region are genetically distinct from those in the eastern tropical Pacific and Hawaiian waters (Mesnick et al. 2011), although occurrence seems to be continuance from California through Hawaii (Barlow and Taylor 2005). The discreteness of the latter two areas remains uncertain (Mesnick et al. 2011).

In the Gulf of Alaska, sperm whales have been sighted along the Aleutian Trench as well as over deeper waters and have been detected acoustically throughout the year (Forney and Brownell Jr. 1996b; Mellinger et al. 2004a). Occurrence is higher from July through September than January through March (Mellinger et al. 2004a; Moore et al. 2006). The vast majority of individuals in the region are likely male based upon whaling records and genetic studies; the area is a summer foraging area for these individuals (Allen and Angliss 2010a; Reeves et al. 1985; Straley and O'Connell 2005; Straley et al. 2005). Mean group size has been reported to be 1.2 individuals (Wade et al. 2003b; Waite 2003). However, female groups may rarely occur at least up to the central Aleutian Islands (Fearnbach et al. 2012).

4.2.6.3 ***Movement***

Mature males range between 70º N in the North Atlantic and 70º S in the Southern Ocean (Perry et al. 1999; Reeves and Whitehead 1997), whereas mature females and immature individuals of both sexes are seldom found higher than 50º N or S (Reeves and Whitehead 1997). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring et al. 1993a) where adult males join them to breed. Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead et al. 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km apart and only rarely have been known to move over 4,000 km within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred kilometers are common, (i.e. between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 4 km/h. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 km of previous sightings.

4.2.6.4 ***Habitat***

Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins 1977), although Berzin (1971a) reported that they are restricted to waters deeper than 300 m. While deep water is their typical habitat, sperm whales are rarely found in waters less than 300 m in depth (Clarke 1956; Rice 1989a). Sperm whales have been observed near Long Island, New York, in water between 40 to 55 m deep (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf.

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet and Whitehead 1996; Jaquet et al. 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000; Davis et al. 2002; Wormuth et al. 2000). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet et al. 1996; Waring et al. 1993a). Sperm whales over George's Bank were associated with surface temperatures of 23.2 to 24.9° C (Waring et al. 2003).

Local information is inconsistent regarding some aspects of sperm whale habitat utilization. Gregr and Trites (2001) reported that female sperm whales off British Columbia were relatively unaffected by the surrounding oceanography. However, (Tynan et al. 2005) reported increased sperm whales densities with strong turbulence-associated topographic features along the continental slope near Heceta Bank.

4.2.6.5 ***Reproduction***

Female sperm whales become sexually mature at an average of 9 years or 8.25 to 8.8 m (Kasuya 1991). Males reach a length of 10 to 12 m at sexual maturity and take 9 to 20 years to become sexually mature, but require another 10 years to become large enough to successfully breed (Kasuya 1991; Würsig et al. 2000). Mean age at physical maturity is 45 years for males and 30 years for females (Waring et al. 2004). Adult females give birth after roughly 15 months of gestation and nurse their calves for 2 to 3 years (Waring et al. 2004). The calving interval is estimated to be every 4 to 6 years between the ages of 12 and 40 (Kasuya 1991; Whitehead et al.

2008). In the North Pacific, female sperm whales and their calves are usually found in tropical and temperate waters year round, while it is generally understood that males move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters off of the Aleutian Islands (Kasuya and Miyashita 1988). It has been suggested that some mature males may not migrate to breeding grounds annually during winter, and instead may remain in higher latitude feeding grounds for more than 1 year at a time (Whitehead and Arnbom 1987).

Sperm whale age distribution is unknown, but sperm whales are believed to live at least 60 years (Rice 1978b). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980). In addition to anthropogenic threats, there is evidence that sperm whale age classes are subject to predation by killer whales (Arnbom et al. 1987; Pitman et al. 2001).

Stable, long-term associations among females form the core of sperm whale societies (Christal et al. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero et al. 2009). Group sizes may be smaller overall in the Caribbean Sea (6 to 12 individuals) versus the Pacific (25 to 30 individuals)(Jaquet and Gendron 2009). Groups may be stable for long periods, such as for 80 days in the Gulf of California (Jaquet and Gendron 2009). Males start leaving these family groups at about 6 years of age, after which they live in "bachelor schools," but this may occur more than a decade later (Pinela et al. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

4.2.6.6 ***Diving and Social Behavior***

Sperm whales are probably the deepest and longest diving mammalian species, with dives to 3 km down and durations in excess of 2 hours (Clarke 1976; Watkins et al. 1993; Watkins et al. 1985). However, dives are generally shorter (25 to 45 min) and shallower (400 to 1,000 m). Dives are separated by 8 to 11 min rests at the surface (Gordon 1987; Jochens et al. 2006; Papastavrou et al. 1989; Watwood et al. 2006; Würsig et al. 2000). Sperm whales typically travel approximately 3 km horizontally and 0.5 km vertically during a foraging dive (Whitehead 2003). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (rorquals, fur seals, and chinstrap penguins), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

Unlike other cetaceans, there is a preponderance of dive information for this species, most likely because it is the deepest diver of all cetacean species and therefore generates a lot of interest. Sperm whales feed on large and medium-sized squid, octopus, rays and sharks, on or near the ocean floor (Clarke 1986; Whitehead 2002b). Some evidence suggests that they do not always dive to the bottom of the sea floor (likely if food is elsewhere in the water column), but that they do generally feed at the bottom of the dive. Davis et al. (2007) report that dive-depths (100 to

500 m) of sperm whales in the Gulf of California overlapped with depth distributions (200 to 400 m) of jumbo squid, based on data from satellite-linked dive recorders placed on both species, particularly during daytime hours. Their research also showed that sperm whales foraged throughout a 24-hour period, and that they rarely dove to the sea floor bottom (>1000 m). The most consistent sperm whale dive type is U-shaped, during which the whale makes a rapid descent to the bottom of the dive, forages at various velocities while at depth (likely while chasing prey) and then ascends rapidly to the surface. There is some evidence that male sperm whales, feeding at higher latitudes during summer months, may forage at several depths including <200 m, and utilize different strategies depending on position in the water column (Teloni et al. 2007).

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

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

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet and Whitehead 1996; Jaquet et al. 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000; Davis et al. 2002). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet and Whitehead 1996; Waring et al. 1993b). Sperm whales over George's Bank were associated with surface temperatures of 23.2 to 24.9 °C (Waring et al. 2004).

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

4.2.6.7 ***Feeding***

Sperm whales appear to feed regularly throughout the year (NMFS 2006d). It is estimated they consume about 3 to 3.5 percent of their body weight daily (Lockyer 1981). They seem to forage mainly on or near the bottom, often ingesting stones, sand, sponges, and other non-food items (Rice 1989a). A large proportion of a sperm whale's diet consists of low-fat, ammoniacal, or luminescent squids (Clarke 1996; Clarke 1980b; Martin and Clarke 1986). While sperm whales feed primarily on large and medium-sized squids, the list of documented food items is fairly long and diverse. Prey items include other cephalopods, such as octopi, and medium- and large-sized demersal fishes, such as rays, sharks, and many teleosts (Angliss and Lodge 2004; Berzin 1972; Clarke 1977; Clarke 1980a; Rice 1989a). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989a). In some areas of the North Atlantic, however, males prey heavily on the oil-rich squid *Gonatus fabricii*, a species also frequently eaten by northern bottlenose whales (Clarke 1997).

4.2.6.8 ***Vocalization and Hearing***

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

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

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

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

Direct measures of sperm whale hearing have been conducted on a stranded neonate using the auditory brainstem response technique: the whale showed responses to pulses ranging from 2.5 kHz to 60 kHz and highest sensitivity to frequencies between 5 kHz to 20 kHz (Ridgway and Carder 2001). Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 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 echo-sounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975). In the Caribbean, Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial noise generated by banging on a boat hull (Watkins et al. 1985). André et al. (1997)reported that foraging whales exposed to a 10 kHz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re 1 μPa^2 between 250 Hz and 1.0 kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. The full range of functional hearing for the sperm whale is estimated to occur between approximately 150 Hz and 160 kHz, placing them among the group of cetaceans that can hear mid-frequency sounds (Southall et al. 2007).

Sperm whales have been observed by marine mammal observers aboard Navy surface ships during training events and detected on the PMRF range hydrophones; however, MFAS was not active so no behavioral response data exists during naval training events. However, a sperm whale was tagged for a controlled exposure experiment during BRS-10. The sperm whale did not appear to demonstrate obvious behavioral changes in dive pattern or production of clicks (Miller et al. 2012; Sivle et al. 2012; Southall et al. 2011b).

4.2.6.9 ***Status and Trends***

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead 2003).

The most comprehensive abundance estimate for sperm whales we are aware of is from Whitehead (2002a), who estimated that there are approximately 76,803 sperm whales in the eastern tropical Pacific, eastern North Pacific, Hawaii, and western North Pacific, and a worldwide population of 360,000 individuals. The tropical Pacific is home to approximately 26,053 sperm whales and the western North Pacific has approximately 29,674 (Whitehead

2002a). There was a dramatic decline in the number of females around the Galapagos Islands during 1985 to 1999 versus 1978 to 1992 levels, likely due to migration to nearshore waters of South and Central America (Whitehead and Mesnick 2003).

Sperm whales are sighted off Oregon in every season except winter (Green et al. 1992). However, sperm whales are found off California year-round (Barlow 1995; Dohl et al. 1983; Forney et al. 1995), with peak abundance from April to mid-June and from August to mid-November (Rice 1974b).

Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947-1987. This estimate does not account for under-reporting by Soviet whalers, who took approximately 31,000 more individuals than were reported (Ivashchenko et al. 2013). Although the IWC protected sperm whales from commercial harvest in 1981, Japanese whalers continued to hunt sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). In 2000, the Japanese Whaling Association announced plans to kill 10 sperm whales in the Pacific Ocean for research. Although consequences of these deaths are unclear, the paucity of population data, uncertainly regarding recovery from whaling, and re-establishment of active programs for whale harvesting pose risks for the recovery and survival of this species. Sperm whales are also hunted for subsistence purposes by whalers from Lamalera, Indonesia, where a traditional whaling industry has been reported to kill up to 56 sperm whales per year.

NMFS has designated three stocks of sperm whale for management purposes under the MMPA in the north Pacific: (1) the Hawaii stock, (2) the California/Oregon/Washington stock, and (3) the Alaska stock (Carretta et al. 2013a).

4.2.6.10 *Natural Threats*

Sperm whales are known to be occasionally predated upon by killer whales (Jefferson and Baird 1991; Pitman et al. 2001) and large sharks (Best et al. 1984) and harassed by pilot whales (Arnbom et al. 1987; Palacios and Mate 1996; Rice 1989a; Weller et al. 1996; Whitehead 1995). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed (Goold et al. 2002; Wright 2005), direct widespread causes of strandings remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Lambertsen et al. 1987; Smith and Latham 1978).

4.2.6.11 *Anthropogenic Threats*

Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959 to 1983). However, other estimates have included 436,000 individuals killed between 1800 and 1987 (Carretta et al. 2005). However, all of these estimates are likely underestimates due to illegal and inaccurate killings by

Soviet whaling fleets between 1947 and 1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov et al. 1998), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to have become entangled in commercial fishing gear and 17 individuals are known to have been struck by vessels (Jensen and Silber 2004). Japan maintains an active whaling fleet, killing up to 10 sperm whales annually (IWC 2008). In 2009, one sperm whale was killed during western North Pacific surveys (Bando et al. 2010).

Whale-watching vessels are known to influence sperm whale behavior (Richter et al. 2006).
In U.S. waters in the Pacific Ocean, sperm whales are known to have been incidentally captured only in drift gillnet operations, which killed or seriously injured an average of nine sperm whales per year from 1991 to 1995 (Barlow et al. 1997). Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Hill and Demaster 1998; Rice 1989b). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longline gear in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska’s longline fishery was recorded, although the animal was not seriously injured (Hill and Demaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear. An individual was caught and released from gillnetting, although injured, on Georges Bank during 1990. A second individual was freed, but injured, from gillnetting on George’s Bank in 1995. In 1994, a sperm whale was disentangled from gillnet along the coast of Maine. In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating ~32 km off Maine. Ten sperm whale entanglements have been observed in U.S. fisheries since 1990 in the Pacific (Carretta and Enriquez 2012). Two additional whales have been found to die from ingestion of fishing gear (Jacobsen et al. 2010). Overall, it is estimated that 3.8 sperm whales die annually along the U.S. west coast due to fisheries interaction (Carretta et al. 2013b).

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

Ingestion of marine debris can have fatal consequences even for large whales. In 1989, a stranded sperm whale along the Mediterranean was found to have died from ingesting plastic that blocked its' digestive tract (Viale et al. 1992). A sperm whale examined in Iceland had a lethal disease thought to have been caused by the complete obstruction of the gut with plastic marine debris (Lambertsen 1990). The stomach contents of two sperm whales that stranded separately in California included extensive amounts of discarded fishing netting (NMFS 2009). A fifth individual from the Pacific was found to contain nylon netting in its stomach when it washed ashore in 2004 (NMFS 2009). In March 2012, a sperm whale stranded dead, apparently dying as a result of plastic ingestion (de Stephanis et al. 2013).

There have not been any recent documented ship strikes involving sperm whales in the eastern North Pacific, although there are a few records of ship strikes in the 1990s. Two whales described as "possibly sperm whales" are known to have died in U.S. Pacific waters in 1990 after being struck by vessels (Barlow et al. 1997). There is an anecdotal record from 1997 of a fishing vessel that struck a sperm whale in southern Prince William Sound in Alaska, although the whale did not appear to be injured (Laist et al. 2001). More recently in the Pacific, two sperm whales were struck by a ship in 2005, but it is not known if these ship strikes resulted in injury or mortality (NMFS 2009). The lack of recent evidence should not lead to the assumption that no mortality or injury from collisions with vessels occurs as carcasses that do not drift ashore may go unreported, and those that do strand may show no obvious signs of having been struck by a ship (NMFS 2009). Worldwide, sperm whales are known to have been struck 17 times out of a total record of 292 strikes of all large whales, 13 of which resulted in mortality (Jensen and Silber 2003; Laist et al. 2001). Given the current number of reported cases of injury and mortality, it does not appear that ship strikes are a primary threat to sperm whales (Whitehead 2003).

4.2.6.12 *Critical Habitat*

The NMFS has not designated critical habitat for sperm whales.

5 ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, Federal, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR § 402.02). The environmental baseline for this Opinion includes the effects of several activities that affect the survival and recovery of ESA-listed resources in the Action Area.

The following information summarizes the principal natural and human-caused phenomena in the Action Area believed to affect the survival and recovery of ESA-listed species in the wild.

5.1 Climate Change

The latest Assessment Synthesis Report from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) concluded climate change is unequivocal (IPCC 2014). The Report concludes oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m have warmed by 0.11 ^{o}C per decade over the period 1971 to 2010) (IPCC 2014). Global mean sea level rose by 0.19 m between 1901 and 2010, and the rate of sea-level rise since the mid-19th century has been greater than the mean rate during the previous two millennia (IPCC 2014). Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney 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.

Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). 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. MacLeod (2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected.

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 (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990). (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 et al 1996; Sydeman et al 2009; Doney et al 2012). In the past, warming events have resulted in reduced food supplies for marine mammals along the U.S. west coast (Feldkamp 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 (Benson et al. 2002; Danil and Chivers 2005; Lusseau et al. 2004; Norman et al. 2004; Shane 1994; Shane 1995). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio 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. Given a lack of available information within the context of the temporal scale of the action, specific climate change related impacts on the species evaluated in this Opinion are speculative, cannot be meaningfully assessed, and will not be considered further.

5.2 Vessel strike

Though vessel strikes are a known source of injury and mortality for cetaceans worldwide, documenting such events is challenging, particularly in remote areas such as Alaska (Neilson et al. 2012). Vessel strikes may go unreported because operators may not report the strike or because they may not detect it. Vessel speed and size appears to be particularly important in predicting collision rates and their outcomes (Neilson et al. 2012). For example, Silber et al. (2010) determined that during close encounters with whales, reduced ship speeds decreased the probability of a collision. Laist et al. (2001) determined that most ship strikes resulting in death or serious injury involved ships traveling 14 knots or faster and ships greater than 80 m in length. Neilson et al. (2012) evaluated documented whale vessel strikes in Alaskan waters that occurred from 1978 to 2011. During that time, a total of 108 collisions were documented. The large majority of the documented strikes were of humpback whales (n=93) in southeastern Alaska. Fin whales (n=3), sperm (n=1), and gray whales (n=1) were also struck in Alaska during this time period. All sizes of vessels struck whales (ranging from < 15m to > 80 m), but small vessel strikes were most common.

With the information available, we know interactions occur, but available literature does not allow us to determine what degree ship strikes impact the survival and recovery of cetaceans. This is particularly true given the lack of information on interactions between whales and vessels outside of U.S. waters in the North Pacific Ocean. The one exception is the blue whale. Monnahan et al. (2014) used a population dynamics model to assess the trends and status of Eastern North Pacific blue whales, and the effects of ship strikes. The authors estimate the ENP blue whale population is currently at 97 percent carrying capacity, and that it would take an 11-fold increase in the current number of vessels for the population to have a 50 percent chance of being below its maximum level of productivity, and thus depleted due to ship strike. Based on this information, we can conclude that ship strikes are not inhibiting the survival and recovery of ENP blue whales.

The potential effects of cetacean interactions with vessels that do not result in ship strike are discussed below (e.g., exposure to vessel noise, behavioral avoidance of vessel).

5.3 Ambient and Anthropogenic Noise

Due to their use of sound in navigating, locating prey, mating, and communicating, marine organisms may be expected to choose their locations and modify their behavior based, in part, on natural and anthropogenic background noise. Noise in the ocean is the result of both natural and anthropogenic sources. Natural sources of noise include processes such as earthquakes, wind-driven waves, rainfall, bio-acoustic sound generation, and thermal agitation of the seawater. Anthropogenic noise is generated by a variety of activities, including shipping; oil and gas exploration, development, and production (e.g., air-guns, ships, oil drilling); naval operations (e.g., military sonars, communications, and explosions); fishing (e.g., commercial/civilian sonars, acoustic deterrent, and harassment devices); research (e.g., air-guns, sonars, telemetry, communication, and navigation); and other activities such as construction, icebreaking, and recreational boating. Sources of anthropogenic noise are becoming more pervasive, increasing oceanic background noise levels as well as peak sound intensity levels. Many anthropogenic sources of noise are located along shipping routes and encompass coastal and continental shelf waters, areas that represent important marine habitat.

5.3.1 Deep Water Ambient Noise

Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean (e.g., offshore habitats below the surface). Shipping, seismic activity, and weather are primary causes of deep-water ambient noise. Noise levels between 20 and 500 Hz appear to be dominated by distant shipping noise. Above 300 Hz, the level of wind-related noise occasionally exceeds shipping noise. Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 to 50,000 Hz. The frequency spectrum and level of ambient noise can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick 1983). For frequencies between 100 and 500 Hz, Urick (1983) has estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas. Underwater ambient noise within the SOCAL Range Complex has higher than average noise (78 to 86 dB) at low frequencies (100 to 500 Hz), owing to the dominance of ship noise at frequencies below 100 Hz and local wind and waves above 100 Hz (Hildebrand et al. 2012). In addition, there is monthly variation including noise peaks at 15 to 30 Hz and also 47 Hz related to the presence of blue and fin whale calls (Hildebrand et al. 2012).

5.3.2 Shallow Water Ambient Noise

In contrast to deep water, ambient noise levels in shallow waters (i.e., surface waters, coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include shipping and industrial activities, wind and waves, and marine animals (Urick 1983). At any given time and place, the ambient noise level is a mixture of these noise types. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope, and type of bottom. Where the bottom is reflective, the sound levels tend to be higher than when the bottom is absorptive.

5.3.3 Anthropogenic Sources

Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Jasny et al. 2005; NRC 2003b; Richardson and Wursig 1995). McDonald observed an increase in low-frequency noise of 10 to 12 dB over 39 years at a site off the southern California coast (2006a), (MMC 2007). A variety of anthropogenic noise sources have been identified in the Action Area, including vessel noise from shipping and other activities, military training and testing (addressed in section 0 below), and seismic survey work associated with research and the oil and gas industry.

5.3.3.1 ***Vessel noise and commercial shipping***

Much of the increase in noise in the ocean environment is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003b) (Hildebrand 2009) (McKenna et al. 2012). Shipping constitutes a major source of low-frequency noise in the ocean, particularly in the Northern Hemisphere where the majority of ship traffic occurs. At frequencies below 300 Hz, ambient noise levels are elevated by 15 to 20 dB when exposed to sounds from ships at a distance (McKenna et al., 2013). Analysis of noise from ships revealed that their propulsion systems are a dominant source of radiated underwater noise at frequencies <200 Hz (Ross 1976). Additional sources of ship noise include rotational and reciprocating machinery that produces tones and pulses at a constant rate.

Individual vessels produce unique acoustic signatures, although these signatures may change with ship speed, vessel load, and activities that may be taking place on the vessel. Peak spectral levels for individual commercial ships are in the frequency band of 10 to 50 Hz and range from 195 dB re μPa^2/Hz at 1 m for fast-moving (> 20 knots) supertankers to 140 dB re μPa^2/Hz at 1 m for small fishing vessels (NRC 2003b). Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency (1 to 5 kHz) range and at moderate (150 to 180 dB re 1 μPa @ 1 m) source levels (Erbe 2002b) (Gabriele et al. 2003) (Kipple and Gabriele 2004). On average, noise levels are higher for the larger vessels, and increased vessel speeds resulted in higher noise levels.

Measurements made over the period 1950 through 1970 indicated low-frequency (50 Hz) ship traffic noise in the eastern North Pacific and western North Atlantic Oceans was increasing by 0.55 dB per year. Data obtained in the northeast Pacific from 1978 to 1986 suggest the 0.55 dB/year increase seen in the early data continued to around 1980, but then slowed to about 0.2 dB/year (Chapman and Price 2011).

The scientific community recognizes the addition of anthropogenic sound to the marine environment as a stressor that could possibly harm marine animals or significantly interfere with their normal activities (NRC 2005). The species considered in this Opinion may be impacted by noise 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 noise levels, changes in diving behavior, or changes in vocalization (MMC 2007).

Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and fixed-wing aircraft, boats and ships, as well as dredging and construction (Richardson et al. 1995). Most observations have been limited to short term behavioral responses, which included temporary cessation of feeding, resting, or social interactions, however, habitat abandonment can lead to more long-term effects which may have implications at the population level. 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 could 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 blue and fin 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 (McDonald et al. 2006c) (Parks 2003) (Parks 2009). Physical injury could also occur if an animal is exposed to high intensity sound of relatively short duration (e.g., exposure to airguns).

5.3.3.2 *Seismic Surveys*

Seismic surveys are the primary means for finding and monitoring fossil fuel reserves and are also used by the scientific community (MMC 2007). Seismic surveys use an array of airguns which emit low-frequency sound into the marine environment (Hildebrand 2005)(Dragoset 2000). Numerous seismic surveys have been undertaken in the Action Area and its surrounding region over the past 35 years (e.g., Turner et al. 1987). ESA-listed cetaceans are long-lived individuals whose experience likely includes prior exposure to seismic sound sources. Prior exposure could lead to habituation, sensitization, or other changes to future exposure based upon prior experience. Significant attention has been paid to the potential impact of seismic airguns on ESA-listed species.

(Gordon et al. 2004) found that marine mammals can be impacted by the intense, broadband pulses produced by seismic airguns through: hearing impairment (temporary threshold shift (TTS) or permanent threshold shift (PTS)); physiological changes such as stress responses; impacting their prey; behavioral alterations such as avoidance responses, displacement, or a change in vocalizations; or through masking (obscuring sounds of interest). Responses can differ according to context, sex, age class, or species.

Generally, only the area within 500 m of the seismic vessel is observed, yet high noise levels can occur at much greater distances. (Madsen et al. 2006) discovered that in the Gulf of Mexico received levels can be as high at a distance of 12 km from a seismic survey as they are at 2 km (in both cases >160 dB peak-to-peak). Received levels, as determined from acoustic tags on sperm whales, generally fell at distances up to 8 km from the seismic survey, only to increase again at greater distances (Madsen et al. 2006).

5.3.3.3 ***Potential population-level impacts of anthropogenic noise***

It is clear that impacts may result from increased levels of anthropogenic-induced background noise or high intensity, short-term anthropogenic sounds. The majority of impacts will likely be short-term behavioral responses, although more serious impacts are possible. Despite the potential for these impacts to affect individual animals, information is not currently available to determine the potential population level effect of anthropogenic sound levels in the marine environment (MMC 2007) on ESA-listed marine mammals and sea turtles. More information would be required including, but not limited to, empirical data on how sound impacts an individual’s growth and vital rates, how these changes impact that individual’s ability to reproduce successfully, and then the relative influence of that individual’s reproductive success on the population being considered. As a result, the consequences of anthropogenic sound on threatened and endangered marine mammal and sea turtles at the population or species scale remain uncertain.

5.4 Whaling

Large whale population numbers in the Action Area have historically been impacted by commercial exploitation, mainly in the form of whaling. Prior to current prohibitions on whaling, most large whale species had been significantly depleted. Table 3 lists the reported catches of all whale species considered in this Opinion and the year in which the International Whaling Commission (IWC) issued a moratorium on harvest of that species.

Table 3. Reported Catch of Endangered Whales Considered in This Opinion, in the North Pacific Ocean

Species	Estimated total catch	Data years	Source	IWC moratorium
Blue whale	9,500 whales	1910 - 1965	(Ohsumi and Wada 1972)	1966
Fin whale	46,000 whales	1919 - 1945	(C. Allison, IWC, pers. comm.; cited in : (Carretta et al. 2014)	1976
Humpback whale	15,000 whales	1919 - 1987	(Tonnessen and Johnsen 1982); C. Allison, IWC unpubl. Data; cited in: (Carretta et al. 2014)	1966
Sei whale	61,500 whales	1947 - 1987	(C Allison, IWC, pers. comm.(Allison 2007)	1976
Sperm whale	258,000 whales	1947 - 1987	(C. Allison, IWC, pers. comm.; cited in: (Carretta et al. 2014)	1988

These whaling numbers represent minimum catches, as illegal or underreported catches are not included. For example, recently uncovered Union of Soviet Socialist Republics catch records indicate extensive illegal whaling activity between 1948 and 1979, with a harvest totalling 157,680 sperm whales in the North Pacific Ocean (Ivashchenko et al. 2014). Of these, only 132,505 were reported by the USSR to the Bureau of International Whaling Statistics. Additionally, despite the moratorium on large-scale commercial whaling, catch of some of these species still occurs in the Pacific Ocean whether it be under objection of the IWC, for aboriginal subsistence purposes, or under IWC special permit. From 1985 through 2013, 1089 sei whales and 444 sperm whales were harvested. Although these fisheries operate outside of the Action Area, some of the whales killed in these fisheries are likely part of the same populations 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 these species has been eliminated. However, as described in greater detail in the *Status of the Species* section of this Opinion, all whale species have not recovered from those historic declines. Scientists cannot determine if those initial declines continue to influence current populations of most large whale species in the North Pacific. For example, the North Pacific right and Western North Pacific gray whales have 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, species such as humpback and blue whale have increased substantially from post-whaling population levels and appear to be recovering despite the impacts of ship strikes, interactions with fishing gear, and increased levels of ambient sound in the Pacific Ocean.

5.5 Fisheries Interactions

Marine mammals may be impacted by fisheries through entrapment or entanglement in actively fished gear, or may be impacted through entanglement in, or ingestion of, derelict fishing gear.

Additionally, some marine mammals considered in this Opinion have the potential to be impacted indirectly if a fishery reduces the available prey base for higher trophic level organisms. Due to their highly migratory nature, many species considered in this Opinion have the potential to interact with fisheries both in and outside of the Action Area. Assessing the impact of fisheries on such species is difficult, due to the large number of fisheries that may interact with the animals, and the inadequate protected species monitoring that occurs in many of those fisheries. For a comprehensive list of U.S. commercial fisheries that may interact with marine mammals in the North Pacific Ocean see NMFS (2013, Appendix 3).

The vast majority of documented cases of baleen whale entanglements with fishing gear are from actively fished gear (NOAA 2014). Entanglement in fishing gear can result in serious injury and mortality to cetaceans. From 2003 to 2007, an average of 3.4 humpback whales per year were seriously injured or killed due to entanglements with commercial fishing gear in Alaskan waters (Allen and Angliss 2013). Mortality and serious injury numbers are minimum estimates as some interactions go unobserved. For example, whales may swim away with portions of the net, not allowing fishery observers or fishers to document the interaction (Carretta et al. 2014). Additionally, since cetaceans occurring in the Action Area are migratory, these populations are likely to interact with fisheries and derelict gear from outside the Action Area. For example, many of the humpback whales that occur in the Action Area migrate to and from Hawaii or the U.S. West coast. For example, between 2007 and 2011, 16 documented humpback whale interactions occurred with pot and trap fisheries off the U.S. west coast, and in all instances, the whale either died or was seriously injured. During the same time period and in the same area, gill nets and unidentified fisheries accounted for 10 documented interactions with humpback whales, with one mortality and nine serious injuries (Carretta et al. 2013a). From November 2009 through April 2010, the Hawaii Whale Entanglement Response Network received 32 reports of entangled humpback whales from fishing gear including longline, monofilament (hook and line), and local crab pot (trap) gear (Navy 2013). Reports of fin whale entanglement are less common than for humpbacks off the U.S. west coast. Only one fin whale death has been observed in fisheries off the California coast (observed in the swordfish drift gillnet fishery) since 1990. In Hawaii, the two longline fisheries that may interact with large marine mammals (the deep-set longline fishery and the shallow-set longline fishery) did not document a fin whale interaction between 2007 and 2011 (Bradford and Forney 2013; McCracken 2013).

5.6 Marine Debris

Anthropogenic marine debris is prevalent throughout the Action Area, originating from a variety of oceanic and land-based sources. Debris can be introduced into the marine environment by its improper disposal, accidental loss, or natural disasters (Watters et al. 2010), and can include plastics, glass, derelict fishing gear, derelict vessels, or military expendable materials. Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it. Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (Academies 2008).

As noted above in the fisheries interactions section of the Environmental Baseline, entanglement or entrapment in derelict fishing gear can pose a threat to many of the species considered in this Opinion. The vast majority of reported cases of entangled baleen whales in the U.S. are humpbacks, with most of these interactions likely involving actively fished, rather than derelict, gear (Program 2014). In Alaska, only 24 percent of documented entanglements were from unknown sources, possibly including marine debris, with the rest of the cases being from a known fishery and likely being actively fished (Jensen et al. 2009). As noted previously, it is likely that some animals interact with fishing gear outside of the Action Area, become entangled, and bring that gear with them when they migrate to the Action Area. For example, 10 humpbacks with entangled gear observed in Hawaii have also been sighted with entangled gear in Alaska, with one animal traveling over 2,450 nautical miles with gear attached (Lyman 2012).

Anthropogenic marine debris can also be accidentally consumed while foraging. Recently weaned juveniles, who are investigating multiple types of prey items, may be particularly vulnerable to ingesting non-food items (Baird and Hooker 2000) (Schuyler et al. 2013). This can have significant implications for an animal's survival, potentially leading to starvation or malnutrition, or internal injuries from consumption. 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 et al. 2010). One whale was emaciated, and the other had a ruptured stomach. It was suspected that gastric impaction was the cause of both deaths. Jacobsen et al. (2010) speculated that the debris likely accumulated over many years, possibly in the North Pacific gyre that would carry derelict Asian fishing gear into eastern Pacific waters.

5.7 Scientific Research

Scientific research permits issued by the NMFS currently authorize studies on listed species in the North Pacific Ocean, some of which extend into portions of the Action Area. Authorized research on ESA-listed whales includes close vessel and aerial approaches, biopsy sampling, tagging, ultrasound, exposure to acoustic activities, and breath sampling. Research activities involve non-lethal "takes" of these whales. From 2009 to 2016, no lethal takes of the species considered in this Opinion were authorized. Table 4 describes the cumulative number of takes for each listed species in the Action Area authorized by scientific research permits.

Table 4. Authorized takes of listed whales, pinnipeds, and sea turtles in the Pacific Ocean under the Endangered Species Act and the Marine Mammal Protection Act.

Species	2009-2016 sub-lethal take
Blue Whale	151,037
Fin Whale	222,093
Sei Whale	63,784
Humpback Whale	472,963
North Pacific Right Whale	12,762
Sperm Whale	195,287

See Section 6 of this Opinion for a discussion of the expected responses of large whales to exposure to non-lethal scientific research activities. This section also discusses the potential fitness implications of such exposure and responses.

5.8 Whale Watching

As of 2010, commercial whale watching was a $1 billion global industry per year (Lambert et al. 2010) Private vessels may partake in this activity as well. Numerous commercial whale watching businesses operate in and around the marine waters off Kodiak Island. Additionally, 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 Action Area.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, marine mammal watching is not without potential negative impacts. 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 whale. 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 et al. 1993; Wiley et al. 1995). Several investigators have studied the short term effects of whale watch vessels on marine mammals (Amaral and Carlson 2005; Au and Green 2000; Corkeron 1995; Erbe 2002b; Félix 2001; Magalhaes et al. 2002; Richter et al. 2003; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels. In some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Although numerous short-term behavioral responses to whale watching vessels are documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006b). Christiansen et al. (2014) estimated the cumulative time minke whales spent with whale watching boats in Iceland to assess the biological significance of whale watching disturbances and found that, though some whales were repeatedly exposed to whale watching boats throughout the feeding season, the estimated cumulative time they spent with boats was very low. The authors suggested that the whale watching industry, in its current state, is likely not having any long-term negative effects on vital rates Christiansen et al. (2014). To our knowledge, similar studies have not been conducted in Alaska.

5.9 U.S. Navy activities

The Navy has been conducting training exercises in the North Pacific Oceans and Gulf of Alaska for many years. Monitoring in conjunction with Navy training and testing exercises to determine the effects of active sonar and explosives on marine mammals is ongoing at many locations. Marine mammal responses to Navy training and testing range from no response, to hearing loss and possible death. For a detailed description of the effects Navy training and testing has on marine mammals in the North Pacific Ocean see the most recent biological opinions for the Northwest Training and Testing, Hawaii and Southern California Training and Testing, Marianas Islands Training and Testing, Gulf of Alaska Training, and Testing, and Surveillance Towed Array Sensor System consultations.

5.10 Large Whale Unusual Mortality Event 2015

Since May 2015, elevated large whale mortalities have occurred in the western Gulf of Alaska, encompassing the Action Area, particularly Kodiak Island (Figure 2). As of mid-August 2015, 11 fin, 14 humpback, 1 gray, and 4 unidentified cetaceans have stranded in the area. As of the signing of this Opinion, no definitive cause has been determined for this event.

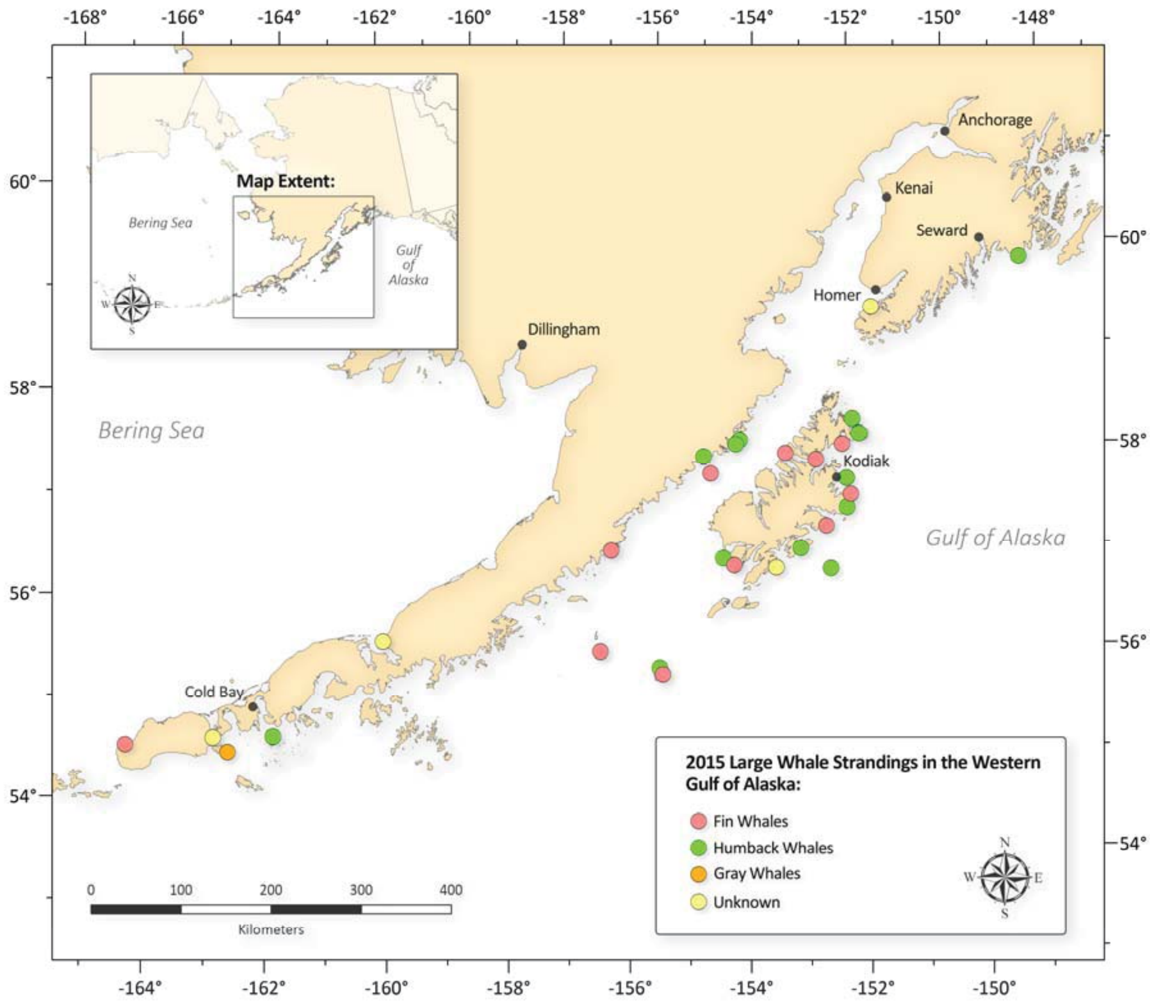

Figure 2. Large whale stranding locations in the Western Gulf of Alaska through August 14, 2015. Map sourced from alaskafisheries.noaa.gov

5.11 Recovery Actions in the Action Area

Recovery is the process by which species' ecosystems are restored and threats to the species are minimized such that ESA-listed species can be self-sustaining. This section addresses ongoing recovery actions that may compensate for effects from stressors in the *Environmental Baseline* and the action assessed in this Opinion. Ongoing conservation actions for ESA-listed cetaceans include, but are not limited to, the following:

- NOAA Fisheries Alaska Protected Resources Division large whale disentanglement efforts (https://alaskafisheries.noaa.gov/protectedresources/entanglement/whale_entanglement_factsheet.pdf).

- Marine Mammal Viewing Guidelines and Regulations (http://alaskafisheries.noaa.gov/protectedresources/mmv/guide.htm);

- Research humpback population structure and abundance including the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project.

5.12 Conclusion on the Impact of the Environmental Baseline

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed species considered in this Opinion. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strike, whaling), whereas others result in more indirect (e.g., a fishery that impacts prey availability) or non-lethal (e.g., whale watching, anthropogenic sound) 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 most of the species in this Opinion are wide ranging and subject to stressors in locations well beyond 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 Table 2, some of the species considered in this Opinion are seeing increases in population abundance, some are declining, and for some, the status remains unknown. Taken together, this indicates that the *Environmental Baseline* is impacting species in different ways. For the species that are increasing in population abundance, they are doing so despite the potential negative impacts of the *Environmental Baseline*. Therefore, while the *Environmental Baseline* described previously 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, it is also possible that their populations are at such low levels (e.g., due to historic commercial whaling) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, they may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself.

A thorough review of the status and trends of each species is presented in the *Status of the Species* section of this Opinion.

6 EFFECTS OF THE ACTION ON SPECIES AND CRITICAL HABITAT

Under Section 7(a)(2) of the ESA, Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed activities authorized by Permit No. 18824 would expose ESA-listed species to close vessel approaches and photography, biopsy sampling, suction cup tagging and subsequent research (e.g., focal follows, evaluation of acoustic pingers). In this section, we describe the:

- potential physical, chemical, or biotic stressors associated with the proposed action

- probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available
- probable responses of those individuals (given probable exposures) based on the available evidence

Any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success) would be assessed to consider the risk posed to the viability of the listed population. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have an effect on the listed population that could appreciably reduce their likelihood of surviving and recovering in the wild.

The proposed action involves non-lethal harassment of ESA listed cetaceans and pinnipeds. The ESA does not define harassment nor has NMFS defined this term, pursuant to the ESA, through regulation. However, the MMPA defines harassment as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild 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" [16 U.S.C. 1362(18)(A)]. The latter portion of this definition ("...causing disruption of behavioral patterns including...migration, breathing, nursing, breeding, feeding, or sheltering") is almost identical to the USFWS' regulatory definition of harass.[5] For the following sections, we define harassment as "an intentional or unintentional act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns essential to the animal's life history or its contribution to the population the animal represents." If we find that the proposed research causes behavioral disruptions that may result in animals that fail to feed or breed successfully, or die, then we will discuss the likely consequences of these disruptions for the population.

6.1 Stressors

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

1) vessel traffic;
2) vessel close approaches to listed species;
3) suction-cup tagging;
4) tag instrument transmissions;
5) operation of the scientific sonar/echosounder
6) biopsy;
7) acoustic deterrent operation;

---

[5] An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.4).

8) collection of sloughed skin and prey remains;
9) collection and export of dead listed mammal parts.

Activities will occur in the Gulf of Alaska, and will be focused on marine waters surrounding Kodiak Island and Shumagin Islands (Figure 1) and will occur annually from the date of the permit's issuance until its expiration (five years from the date of issuance).

6.2 Stressors Not Likely to Adversely Affect ESA-listed Species

Based on a review of available information, we determined the following possible stressors that individual animals would be exposed to would not pose a risk to listed species: vessel traffic; tag instrument transmissions; operation of the scientific sonar/echosounder; collection of sloughed skin and prey remains; and collection and export of dead listed mammal parts.

6.2.1 Vessel traffic

Vessel traffic associated with the proposed research is not expected to pose a measurable risk to ESA-listed species (with the exception of close approach, as described in Section 6.3.2.1). Given the experience of the Applicant in detecting the ESA-listed species considered in this Opinion and conducting similar surveys to those proposed for this permit, the possibility of vessel strike is remote. We expect the Applicant would be able to locate, identify, and avoid all ESA-listed cetaceans and pinnipeds during transit. Additionally, as outlined in Section 2.2, we expect the Applicant to comply with the permit terms and conditions that require the Applicant to exercise caution when approaching animals and require them to retreat from animals if behaviors indicate the approach may be interfering with reproduction, feeding or other vital functions. Further caution is required when approaching females with calves. For these reasons, we consider the likelihood for a vessel strike of an ESA-listed species to be discountable.

Noise from project vessels may be detectable to ESA-listed marine mammals in the Action Area. However, the infrequency of vessels associated with this project is not expected to substantially increase noise levels above background conditions. Any response elicited from ESA-listed species due to vessel noise is expected to be in the form of behavioral avoidance or interruption in behavior and of short duration. We believe any behavioral response of ESA-listed species to vessel noise will be of limited duration and magnitude such that it would not involve fitness consequences from the disruption of breeding, feeding, communication, or sheltering. Therefore, the effects of vessel noise on ESA-listed species are expected to be biologically irrelevant and insignificant.

We also evaluated the potential for a small fuel spill that could occur during project activities to impact ESA-listed species. However, because of the open ocean environment in which the proposed action will occur, the duration and small spatial extent of such a spill, and the wide-ranging life histories and mobility of ESA-listed species that may occur in the Action Area, the effects of a small fuel spill are considered insignificant.

6.2.2 Tag instrument transmissions

During tagging activities, some whales could be exposed to sounds from the VHF tag attachments. As described in the Status of Listed Resources section, we assume the species considered in this Opinion hear best at frequencies at which they vocalize. Based on available information, this includes sounds in the low frequency (i.e., <1 kHz) range. Ketten (1992) indicates that mysticete whales' hearing is limited primarily to very low frequencies <10 kHz. Some tag configurations might include the use of VHF transmitters to aid researchers in locating tags, but the frequency range for these transmitters would be greater than 148 MHz. This is well above the known hearing range for marine mammals. Therefore, the effects of VHF transmissions are considered insignificant not considered further in this Opinion.

6.2.3 Echosounder

The ESA-listed species that may occur in the Action Area may be exposed to underwater sounds associated with prey distribution and bathymetry surveys. The researchers will use a SIMRAD EK60 dual frequency (38 and 120 kHz) commercial echosounder for these purposes.

Though cetacean hearing has not been directly measured, it is generally assumed cetaceans can hear sounds at the frequencies in which they produce vocalizations, although there is some evidence that at least some cetaceans can hear sounds at other frequencies as well. For example:

- Humpback whales have been shown to produce vocalizations at a wide range of frequencies, corresponding to different functions (e.g., feeding, breeding, and other social calls) (Dunlop et al. 2008). Social calls range from 20 Hz to 10 kHz, with dominant frequencies below 3 kHz (D'Vincent et al. 1985; Dunlop et al. 2008; Silber 1986; Simao and Moreira 2005). "Feeding" calls, unlike song and social sounds, are a highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 162 to 192 dB re 1 μPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). Research by Au et al. (Au et al. 2001; Au et al. 2006b) off Hawaii indicated the presence of high-frequency harmonics in humpback whale vocalizations up to and beyond 24 kHz.

- Though blue whales are generally considered "low frequency hearing specialists," the species has been shown to respond to mid-frequency simulated military sonar (Goldbogen et al. 2013; Melcon et al. 2012).

- Sperm whales produce broad-band clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200 to 236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Goold and Jones 1995; Madsen et al. 2003; Weilgart and Whitehead 1997; Weilgart et al. 1993). Most of the energy in sperm whale clicks is concentrated at around 2 to 4 kHz and 10 to 16 kHz (Goold and Jones 1995; NMFS 2006d; Weilgart et al. 1993).

Therefore, the cetacean species that occur in the Action Area may be able to detect and potentially respond to the echosounder, if they were exposed.

Kremser et al. (2005) evaluated the risk of marine mammal auditory damage from multi-beam and single beam echosounders. The authors suggested that impacts would only be expected if an animal moves through the beam very close to the hydroacoustic device. For example, for a vessel traveling at four knots emitting a Parasound single beam echosounder (source level = 245 dB_{rms} re 1µPa$^{\text{-m}}$ at 18kHz), an animal would have to be directly under the vessel (within the beam) and closer than 100 meters to the hydroacoustic device to be exposed to hazardous levels of sound. Additionally, the authors suggested that impacts can be mitigated by implementing prior detection and shut down procedures (Kremser et al. 2005). The authors suggested the probability for a whale to swim into the acoustic source very close to the ship was very small, similar to the probability of vessel strike. Boebel et al. (2005) evaluated the risks posed by a range of acoustic scientific devices, including multi-beam and single beam echosounders. The authors concluded that in almost all circumstances, the use of this equipment would result in no response from exposed individuals, or only a temporary (minutes) behavioral response. Further, only in exceptional circumstances would a longer term (days) response be expected from the use of this equipment. (Lurton and DeRuiter 2011) suggested that hydrogeographic and bottom-mapping sonars provide minimal risk of causing marine mammal auditory damage, though they suggested the potential impacts of these types of equipment on marine mammal behavior are less clear. (Burkhardt et al. 2007) assessed the risk of scientific sonars causing immediate direct injury (e.g., permanent threshold shift), immediate indirect injury (e.g., stranding), and behavioral response under generic open ocean conditions and determined that the equipment evaluated (i.e., multi-beam sonar to map seafloor topography and parametric echosounder to obtain structure of upper sediment layers beneath the sea floor), pose no risks to individuals or populations of marine mammals.

Despite the studies referenced above, the use of a multi-beam echosounder was implicated in the mass stranding of melon headed whales in Madagascar in 2008 (Southall et al. 2013). A team evaluating the likely causes of the stranding event speculated that the echosounder likely brought about a behavioral response in the whales, causing them to leave their pelagic environment and enter a lagoon system, placing them in an unfamiliar and unnatural habitat. We do not expect a similar event from the use of the multi-beam echosounder during this project for a number of reasons. First, melon-headed whales are thought to be one of the more reactive and potentially vulnerable marine mammal species to impacts from powerful acoustic systems (Brownell Jr. et al. 2006; Southall et al. 2006). The ESA-listed species that may occur in the action area are not known to be as sensitive to acoustic stressors as melon-headed whales. Additionally, the Madagascar stranding is the only documented case of an event associated with the use of the multi-beam echosounder, despite their extensive use throughout the world for hydrographic surveys (Southall et al. 2013). This indicates there is a small probability that such an event could occur and that such an event would require a specific set of circumstances not likely to be associated with the acoustic surveys that will be conducted as part of the proposed action.

The information presented above regarding the risk the scientific sonars pose to marine mammals suggests that even if ESA-listed cetaceans are exposed to underwater sound from the echosounder, we would not expect injury or mortality, and any behavioral reactions would be temporary (minutes). Given the wide-ranging life histories of the species that may occur in the action area and the open ocean environment in which this project will occur, animals will be able to temporarily relocate to alternative areas until project activities have ceased in their previously selected location. Potential effects from avoidance behavior are considered insignificant because the behavior would be temporary and would not be expected to increase the likelihood of injury due to the significant disruption of breeding, feeding, or sheltering.

6.2.4 Collection of sloughed skin and prey remains

Parts of marine mammals may be collected following a killer whale predation event using a skim net or sieve. Prey remains would be collected after killer whales depart the area. In addition, sloughed skin from humpback whales will be collected following certain surface activities (i.e., breaching, tail slapping). Sloughed skin will be collected from the site of the surface activity only after the whale has moved greater than 100 yards from the location. Since whales will have either departed the area or passed a safe distance of 100 yards by the time the vessel retrieves prey remains or sloughed skin, the effects of these actions are insignificant and will not be considered further.

6.2.5 Collection and export of dead animal parts

The collection of dead ESA-listed marine mammal parts would result in no effect to these species since the animals will have been removed from the population by other causes prior to the take of their parts.

6.3 Stressors Likely to Adversely Affect ESA-listed Species

The exposure and response analysis of this Opinion will focus on the following potential stressors: 1) vessel close approaches; 2) suction cup tagging; 3) biopsy; and 4) acoustic deterrent operation.

6.3.1 Exposure

Exposure analyses identify the co-occurrence of ESA-listed species with the actions’ effects in space and time, and identify the nature of that co-occurrence. The analysis identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions’ effects and the population(s) or subpopulations(s) those individuals represent. As discussed previously, blue, fin, humpback, North Pacific right, sei, and sperm whales of either gender and any age class could be exposed to stressors associated with the proposed action. Additionally, though not a target species of the research, Steller sea lions from the Western DPS could be disturbed incidentally.

We have assessed the action at the proposed levels for all research activities. However, we believe that in any given year, not all proposed takes would occur since researchers ask for takes based on a desired sample size and account for potential (though not necessarily likely or expected) encounters with large numbers of whales that could occur while conducting field research. The take levels requested and analyzed in this Opinion are below in Table 1. Under the proposed action, exposure to proposed activities would occur each year for five years until the permit's expiration.

The duration of each exposure depends on the duration of close approach and the methods performed after close approach. Tagging of target whales could last 5-10 minutes for close approach and then five seconds or less for the tag or biopsy application. Suction cup tags may remain attached up to 48 hours, but most will only remain attached for 6-8 hours. Following the application of a tag, whales will be monitored for varying amounts of time depending on the research objective. For foraging studies, researchers may conduct focal follows (from between 100 and 500 yards away) for no longer than eight hours per individual or group. For acoustic deterrent studies, once the tag is attached, the whale is monitored for approximately one hour in order to establish pre-acoustic deterrent dive patterns and behaviors. Once this baseline behavior pattern is determined, acoustic deterrent devices will be deployed for short duration lasting less than one minute (emission interval of every 5 seconds, emission duration of 400 m/s) or until any adverse reactions are observed including, but not limited to, vocalization, wheeze blow, and/or tail slap.

6.3.2 Response

As discussed in the *Approach to the Assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after being exposed to an action's stressors. Below we discuss the expected response of ESA-listed whales to close vessel approaches, suction cup tagging, biopsy, and operation of acoustic deterrents.

6.3.2.1 *Close vessel approaches*

The procedure for close vessel approaches was described in Section 2.1.1.1. This section also described the minimization measures the applicant will use in order to minimize disturbance to animals including slowly approaching animals and terminating an approach if signs of disturbance are observed (e.g., changes in behavior, stress vocalizations, abrupt shifts in direction of movement).

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

Numerous studies have documented varied responses of humpback whales to vessel approaches, ranging from no response to approach to evasion (Goodyear 1993; Salden 1993). In response to vessel approach, Felix (2001) found that 27 of 86 individuals approached resulted in avoidance of the vessel (50 were indifferent and 9 approached vessels), including long dive, change in heading, tail splashes, altered swimming speed or breathing frequency, and group structure disruption. Approaching vessels may instigate aerial behavior, such as fluke slapping and breaching, behavior recently suggested to be a switch in communication from vocal to surface active signaling (Baker et al. 1983a; Baker et al. 1983b; Holt et al. 2009). Hall (1982) did not find social or feeding behavior to be disturbed by vessel traffic or close approaches. However, there is the possibility that humpback whales may habituate to vessel noise if given sufficient time and exposure (Clapham and Mattila 1993; Watkins 1986). Goodyear (1983) did not observe changes in behavior due to vessel approaches in most cases, although an increase in speed did occur on one occasion when a whale was approached within 10 m. Cantor et al. (2010) generally found resting or socializing whales to switch to traveling upon approach of their research vessels. Watkins et al. (1981) found that humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startle reaction, and moving away from the vessel with strong fluke motions. Several authors found that humpbacks spent less time at the surface and altered their direction of travel in response to approaching vessels (Baker and Herman 1989; Baker et al. 1983a; Bauer 1986; Bauer and Herman 1986; Green and Green 1990). Increased time underwater and decreased swim speed persisted for up to 20 minutes after vessels left the area. Watkins and Goebel (1984) found humpbacks to be very difficult to approach. Norris (1994) documented changes in humpback song structure in response to passing vessels, with unit and phrase durations reduced versus control periods.

In Alaskan waters, increased dive durations have been observed along with a shift in orientation away from the path of moving boats, often at ranges up to 3-4 km (Baker et al. 1983a) (Baker and Herman 1989). Some approaches in Alaskan waters closer than 100 m initiated evasive behavior (Hall 1982). Watkins (1986) found little response to approaches outside of 100 m away, although humpbacks regularly reacted to outboard vessels on a collision course even from long distance.

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

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

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

Based on the information presented above, we would expect most listed whales exposed to close vessel approaches under the proposed permit to exhibit either no visible reaction or short-term low-level to moderate behavioral responses. Although close approaches conducted under the proposed permit might still be stressful for some individuals, and might temporarily interrupt behaviors such as foraging, evidence from investigators and in the literature suggests that responses would be short-lived. Assuming an animal is no longer disturbed after it returns to pre-approach behavior, we do not expect a negative fitness consequence for the individuals approached. Additionally, it’s worth noting that since the inception of the Applicant’s research program, they have successfully collected over 400 biopsy samples and tagged 13 individuals, all of which required close vessel approach. The researchers have not documented a severe reaction to any of the close vessel approaches and they have never struck a cetacean or pinniped.

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

6.3.2.2 ***Suction cup tagging***

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

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

Based on the available information presented above, we expect responses to consist of brief, low-level to moderate behavioral responses. These are likely to include increased swimming speed, diving, change in direction, lobtail, forceful exhalation, submergence, tail and flipper movements, agonistic behavior, twitches, back arches, and defecation. However, we expect that individuals would return to baseline behavior within a few minutes. Since implementing their research program, the Applicant has successfully tagged 13 individuals. The researchers have never documented a severe reaction to a tagging event. The most significant reaction they have recorded has been a tail flick, which occurs in approximately 1 in every 10 events.

6.3.2.3 ***Biopsy***

We reviewed the literature assessing the impacts of biopsy sampling to various cetacean species. Gauthier and Sears (1999) summarized data for several species, including blue, fin, and humpback. Blue whales responded by submerging, accelerating, and/or diving. They found humpback whales to accelerate, change direction, dive, lobtail, exhale forcefully, submerge, and display tail and flipper movements (the most common response); “moderate” responses were the most common category of response. Inadvertent repeated biopsy within a week did not appear to cause a difference in reaction in three blue whales and five fin whales. Group size does not appear to impact the likelihood or severity of response. Female fin whales appear to respond to biopsy more often than males (66% versus 44%) and more strongly. Individuals generally return to baseline behavior within a few minutes (Gauthier and Sears 1999).

An International Whaling Commission (IWC) working group reviewed biopsy sampling and concluded long-term effects are unlikely, although short-term responses frequently occur (IWC 1991). Clapham and Mattila (1993) found 44% of humpback whales sampled showed no immediate response, while 22.5% reacted in subtle or minor ways. Cerchio (2003) found similar results in 350 biopsy events. Cantor et al. (2010) found that 46% of 542 biopsy attempts on adult or subadult humpback whales from 10-25 m away resulted in a behavioral response (most commonly fluke movement). Neither the use of a tether, the duration of vessel contact with the target individual, nor region of the body hit influenced the likelihood of response, although responses were more frequent and intense from smaller vessels (likely due to their additional noise) than from larger vessels. Weinrich et al. (1992a) found that of 71 humpback whales biopsied, 7% had no response, 27% exhibited a “low” response, 61% had a “moderate” response, and 6% had a “strong” response. Brown et al. (1994) found 41% of 203 humpbacks biopsied to respond in some way, including fluke movements, tail slaps, and disrupted dives. Humpbacks rarely display tail flicks, but frequently do so in response to biopsy (Weinrich et al. 1992a; Weinrich et al. 1992b). Repeated sampling was not found to influence the likelihood of subsequent biopsy responses (Brown et al. 1994). Fin whales were found to either not respond at all, or exhibit low- to moderate-level behavioral responses (Marsili and Focardi 1996).

The behavioral state of individuals pre-biopsy may also influence the probability of response, with foraging, traveling, or socializing individuals less likely to respond than resting individuals (Cantor et al. 2010; Weinrich et al. 1991a). Clapham and Mattila (1993) found that evasion was the most common behavioral change and that response was less likely on breeding grounds. Demographic factors do not appear to influence biopsy response in humpback whales; individual age, gender, group size, geographic location, and repeated sampling have not been found to influence the likelihood of biopsy responses (Cantor et al. 2010; Gauthier and Sears 1999; Weinrich et al. 1991a). Of individuals that do respond, return to baseline behavior occurs within a few minutes (Gauthier and Sears 1999). Mothers and males in competitive groups reacted less frequently than other individuals (Cerchio 2003; Clapham and Mattila 1993). However, calves tend to be more evasive than any other group. Females with calves responded more frequently than did non-lactating females (60% versus 43%) (Cantor et al. 2010).

Biopsy misses can also cause behavioral responses (Gauthier and Sears 1999). Strong behavioral responses were found by Weinrich et al. (1992a) and (1991b) when a line attached to the biopsy dart snagged on an individual’s flukes. Brown et al. (1994) reported that 16% of missed Australian humpbacks responded, suggesting that these animals reacted to the sound of the dart hitting the water. Similarly, Clapham and Mattila (1993) reported that a total of 375 (87.7%) of misses on breeding grounds involved no reaction. Gauthier and Sears (1999) found four out of five misses of individuals in a feeding area did not involve a response, although four out of five other individuals did respond until freed from biopsy darts that stuck in their blubber. Significantly stronger reactions were displayed when biopsy darts actually hit humpback whales than when they missed (Weinrich and Kuhlberg. 1991).

We are not aware of any direct studies of the effect of biopsying on North Pacific right whales. However, North Atlantic right whales have been shown to exhibit immediate, minor behavioral response to biopsy darting 19% of the time in 241 attempts and no reaction in 81% of hits and misses (Brown et al. 1991). Reactions include twitches, increased swimming speed and dives, back arches and dives, tail flicks, lobtails, and turning away from the tagging vessel (Brown et al. 1991). More than 50% of individuals had a hard tail flick; an unusual behavior for this species. Dives also became longer relative to surface times. However, return to baseline behavior generally occurred after the vessel approach was complete (Brown et al. 1991). Reeb and Best (2006) also documented no or low- to moderate-level responses of right whales to pole biopsy techniques. Demographic differences in responses have been identified in southern right whales, with greater response in singletons versus groups and cow/calf pairs responding more strongly than other groups (Best et al. 2005).

We identified only one study that has reported on the response of sperm whales to biopsy attempts. Whitehead et al. (1990) reported responses from sperm whales off Nova Scotia as well as the Azores, finding that every biopsy hit and roughly half of the misses caused a startle response. Startling was associated with flexing the body, raising the back, and/or increasing swimming speed. Other responses occasionally observed included short dives of up to five minutes and defecation. In all cases, individuals were observed to return to baseline behavior within minutes.

We know of only one published report of a cetacean death following biopsy sampling, when the dart penetrated the muscle mass of a female common dolphin (*Delphinus delphis*), which may have resulted in vertebral trauma and severe shock (Bearzi 2000). The individual had relatively thin blubber, permitting deeper penetration than was desired and sticking of the dart. Additionally, there is no evidence of infection at the point of penetration or elsewhere among the many whales sighted in the days following biopsy sampling (Weller 2008). The risk of infection is thought to be minimized by sterilizing dart tips before sampling occurs. In general, healing is rapid (roughly one week, scarring thereafter) (Noren and Mocklin 2011).

We expect responses to consist of brief, low-level to moderate behavioral responses. These responses may include increased swimming speed, diving, change in direction, lobtail, forceful exhalation, submergence, tail and flipper movements, agonistic behavior, twitches, back arches, or defecation. As a result, individuals may temporarily leave the immediate area or cease feeding, resting, or other activities. However, we expect that individuals would return to baseline behavior within a few minutes. Additionally, because the applicant will be cleaning and sanitizing all biopsy darts prior to each subsequent use, we do not expect any infections to result from this activity. Since implementing their research program, the Applicant has successfully collected over 400 biopsy samples. During the collection of those samples, the researchers have never documented a severe reaction to a sampling event. The most significant reaction they have recorded has been a tail flick, which occurs in approximately 1 in every 10 events. Additionally, conspecifics or non-target species have never shown any adverse reaction to the biopsy procedure. Based on the available literature and the applicant's previous experience collecting biopsy sampling with no significant reactions observed, we do not expect biopsy sampling to impact the fitness of any individuals.

6.3.2.4 ***Acoustic deterrent operation***

Acoustic deterrent devices (ADDs) are one of the most common methods used to reduce interactions between marine mammals and actively fished fishing gear. Pingers are a specific type of ADD, which use relatively low sound levels, and have been shown to be effective in reducing fishery interactions for a number of marine mammal species (Schakner and Blumstein 2013). For the acoustic deterrent portion of this research, the Applicant will set an F3 'pinger' in the water to at least one meter depth with a frequency of 3 kHz and source level of 135 dB re 1 µPa. The researchers calculated that the F3 pinger would have a received level of 118 dB re 1 µPa at a distance of 100 meters from the source. The acoustic deterrent device will be deployed for short durations lasting less than one minute with an emission interval of every five seconds (emission duration of 400 m/s). Deployment will cease if any adverse reactions are observed including, but not limited to, vocalization, wheeze blow, and/or tail slap. Any observed abrupt changes in these parameters immediately after acoustic deterrent device deployment signify a response to the sound generated. The F3 pinger that will be tested is currently being used by commercial fisherman throughout the state of Alaska to deter cetaceans from entanglement in fishing gear.

We do not expect the operation of acoustic deterrents to result in physiological consequences to any exposed individuals. The low source level (135 dB re 1 µPa) of the deterrent device suggests this is unlikely. For example, in cooperation with NMFS, the Navy has established criteria for predicting the onset of temporary and permanent threshold shift for marine mammals from sonar and impulsive acoustic stressors such as explosions. Under these guidelines, the onset of TTS or PTS is not expected until sound exposure levels reach much higher levels than are anticipated from this action. Higher level injuries (e.g., GI tract or lung injury) are not expected until even higher exposure levels (e.g.,DoN 2013). Further, other devices, termed acoustic harassment devices have a similar goal of deterring marine mammals from interacting with fishing gear, but operate with much higher sound pressure levels (e.g., 195 dB re 1 µPa at 1 m) designed to strike critical thresholds causing pain or discomfort based on the hearing sensitivity of the target species (Petras 2003). The F3 pingers that will be used in this study will emit sound at much lower levels than these sources.

Short-term behavioral responses to acoustic deterrents are expected since the basic goal of the pinger is to elicit a behavioral response from the marine mammal that would, when implemented by the fishing industry, result in the animal avoiding a potentially lethal interaction with fishing gear. However, these behavioral responses are expected to be similar in nature and duration to those described above for close vessel approaches. The behavioral response would likely include a startle response and avoidance of the immediate area (Jefferson and Curry 1996; Schakner and Blumstein 2013). However, we expect that individuals would return to baseline behavior within a few minutes. For these reasons, we would not expect the operation of acoustic deterrents in this research to result in fitness consequences for any of the species considered in this Opinion.

6.4 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, NMFS searched for information on future state, tribal, local, or private actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the *Environmental Baseline,* which we expect will continue into the future. Anthropogenic effects include commercial fishing, vessel traffic, ocean noise, pollution, discharged contaminants, and coastal development. 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.

6.5 Integration and Synthesis

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment.

The *Status of Listed Resources* described the factors that have contributed to the reduction in population size for the species considered in this Opinion. Threats to the survival and recovery of these species include, but are not limited to, fisheries interactions, ship strikes, noise, and scientific research. NMFS expects that the current natural and anthropogenic threats described in the *Environmental Baseline* will continue. We did not find any likely future actions that could affect the species considered in this Opinion beyond those described in the *Environmental Baseline*.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the issuance of Permit No. 18824 to Briana Witteveen for research on marine mammals in the Gulf of Alaska would not be expected to appreciably reduce the likelihood of the survival or recovery of blue, fin, humpback[6], North Pacific right, sei, or sperm whales in the wild by reducing the reproduction, numbers, or distribution of those species. As described in Section 6 of this Opinion, stressors associated with the proposed action will not affect the population dynamics, behavioral ecology, and social dynamics of individual ESA-listed whales in ways or to a degree that would reduce their fitness. Under the proposed permit, listed whales would be exposed to the following potential stressors:

---

[6] On April 21, 2015, NMFS proposed to divide the globally listed endangered humpback whale population into 14 DPSs (80 FR 22304). The humpback whales in the Action Area may belong to the proposed threatened Western North Pacific DPS, or to the Hawaii or Mexico DPSs which, as proposed, would not be listed under the ESA. If this rule is finalized, the same conclusion holds in that the proposed action would not be expected to appreciably reduce the likelihood of the survival or recovery of the Western North Pacific DPS of humpback whales in the wild by reducing the reproduction, numbers, or distribution of this species.

1) vessel transit and tracking;
2) vessel close approaches to listed species;
3) suction-cup tagging;
4) tag instrument transmissions;
5) operation of the scientific sonar/echosounder
6) biopsy;
7) acoustic deterrent operation;
8) collection of sloughed skin and prey remains;
9) collection and export of dead listed mammal parts.

Of those potential stressors, we determined that only vessel close approaches, suction-cup tagging, biopsy, and acoustic deterrent operation were likely to adversely affect ESA-listed whales. We believe short-lived behavioral reactions are possible, but we do not expect these responses to lead to reduced opportunities for foraging, reproduction or other essential life functions for target or non-target individuals. Overall, no individual whale is expected to experience a fitness reduction from the proposed action. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). For these reasons, we do not anticipate any reductions in survival rate or trajectory of recovery of the whale species considered in this Opinion.

7 CONCLUSION

During the consultation, we reviewed the current status of endangered blue, fin, humpback, North Pacific right, sei, and sperm whales. Additionally, we assessed the status of the proposed threatened western North Pacific DPS of humpback whales as part of our Conference Report. We also assessed the *Environmental Baseline* within the Action Area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects.

Our regulations require us to consider, using the best available scientific data, effects of the action that are "likely" and "reasonably certain" to occur rather than effects that are speculative or uncertain. See 50 C.F.R. § 402.02 (defining to "jeopardize the continued existence of" and "effects of the action"). For the reasons set forth above, and taking into consideration the best available scientific evidence documented throughout this Opinion and Conference Report, we conclude that the issuance of permit No. 18824 to Briana Witteveen for research on marine mammals in the Gulf of Alaska is unlikely to lead to any fitness consequences to any individuals or affected species. Therefore, it is NMFS' opinion that the issuance of permit number 18824 is likely to adversely affect, but is not likely to jeopardize the continued existence of, blue, fin, humpback, North Pacific right, sei, and sperm whales. Additionally, if the proposed rulemaking becomes effective and if the proposed listing is finalized as proposed and assessed in this Opinion and Conference Report, we conclude that the issuance of permit number 18824 would likely adversely affect, but not jeopardize the continued existence of, the proposed threatened western North Pacific DPS of humpback whales.

8 INCIDENTAL TAKE STATEMENT

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

As discussed in the accompanying Opinion, only the species targeted by the proposed research activities would be harassed as part of the intended purpose of the proposed action. Therefore, the NMFS does not expect the proposed action would incidentally take threatened or endangered species.

9 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to:

- minimize or avoid adverse effects of a proposed action on listed species or critical habitat
- help implement recovery plans
- develop information

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

- We recommend that the Permits Division continue to develop a programmatic approach to research permit consultations on a species-specific or geographic basis, or other programmatic approach. A programmatic approach to research permit consultations would allow for a better understanding of all proposed research efforts and their effects to populations and would expedite issuance of individual research permits.

In order for NMFS's ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, listed species or their habitats, the

Permits Division should notify the ESA Interagency Cooperation Division of any conservation recommendations they implement in their final action.

10 REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed issuance of permit number 18824 to Briana Witteveen to conduct research on marine mammals in the Gulf of Alaska. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the Permit Holder and NMFS' Permits Division must contact the ESA Interagency Cooperation Division, Office of Protected Resources immediately.

11 REFERENCES

Aburto, A., D. J. Rountry, and J. L. Danzer. 1997. Behavioral response of blue whales to active signals. Naval Command, Control and Ocean Surveilance Center, RDT&E Division.

Academies, N. R. C. o. t. N. 2008. Tackling marine debris in the 21st Century. Committee on the Effectiveness of International and National Measures to Prevent and Reduce Marine Debris and Its Impacts.

Agler, B. A., and coauthors. 1990. Fin whale (*Balaenoptera physalus*) photographic identification: Methodology and preliminary results from the western North Atlantic. Report of the International Whaling Commission Special Issue 12:349-356.

Agler, B. A., R. L. Schooley, S. E. Frohock, S. K. Katona, and I. E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. Journal of Mammalogy 74(3):577-587.

Aguayo, L. A. 1974. Baleen whales off continental Chile. Pages 209-217 *in* W. E. Schevill, editor. The Whale Problem: A Status Report. Harvard University Press, Cambridge, Massachusetts.

Aguilar, A. 1983. Organochlorine pollution in sperm whales, Physeter macrocephalus, from the temperate waters of the eastern North Atlantic. Marine Pollution Bulletin 14(9):349-352.

Aguilar, A., and A. Borrell. 1988. Age- and sex-related changes in organochlorine compound levels in fin whales (Balaenoptera physalus) from the eastern North Atlantic. Marine Environmental Research 25:195-211.

Aguilar, A., and C. H. Lockyer. 1987. Growth, physical maturity, and mortality of fin whales (*Balaenoptera physalus*) inhabiting the temperate waters of the northeast Atlantic. Canadian Journal of Zoology 65:253-264.

Alava, J. J., M. J. Barragan, and J. Denkinger. 2012. Assessing the impact of bycatch on Ecuadorian humpback whale breeding stock: A review with management recommendations. Ocean and Coastal Management 57:34-43.

Allen, B. M., and R. P. Angliss. 2010a. Alaska Marine Mammal Stock Assessments, 2009. U.S. Department of Commerce.

Allen, B. M., and R. P. Angliss. 2010b. Humpback whale (*Megaptera novaeangliae*): Western North Pacific stock. Pages 179-187 *in* Alaska Marine Mammal Stock Assessments, 2010, volume Technical Memorandum-AFSC-223. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, Washington.

Allen, B. M., and R. P. Angliss. 2013. Alaska marine mammal stock assessments, 2012. NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center.

Allison, C. 2007. IWC summary catch database. International Whaling Commission.

Alter, S. E., E. Rynes, and S. R. Palumbi. 2007. DNA evidence for historic population size and past ecosystem impacts of gray whales. Proceedings of the National Academy of Sciences of the United States of America 104(38):15162-15167.

Amano, M., A. Kourogi, K. Aoki, M. Yoshioka, and K. Mori. 2014. Differences in sperm whale codas between two waters off Japan: Possible geographic separation of vocal clans. Journal of Mammalogy 95(1):169-175.

Amaral, K., and C. Carlson. 2005. Summary of non-lethal research techniques for the study of cetaceans. United Nations Environment Programme UNEP(DEC)/CAR WG.27/REF.5.

3p. Regional Workshop of Experts on the Development of the Marine Mammal Action Plan for the Wider Caribbean Region. Bridgetown, Barbados, 18-21 July.

Anderson, J. J. 2000. A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70(3):445-470.

André, M., M. Terada, and Y. Watanabe. 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. 1916. The sei whale (*Balaenoptera borealis* Lesson). Memoirs of the American Museum of Natural History, New Series 1(6):291-388.

Angliss, R. P., and K. L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, NMFS-AFSC-144.

Angliss, R. P., and R. B. Outlaw. 2008. Alaska marine mammal stock assessments, 2007. Department of Commerce, NMFS-AFSC-180.

Anonmyous. 2009. Blue whales re-establishing former migration patterns. Marine Pollution Bulletin 58(7):949.

Archer, F., and coauthors. 2013. Mitogenomic phylogenetics of fin whales (*Balaenoptera physalus* spp): Genetic evidence for revision of subspecies. PLOS One 8(5):e63396.

Arnbom, T., V. Papastavrou, L. S. Weilgart, and H. Whitehead. 1987. Sperm whales react to an attack by killer whales. Journal of Mammalogy 68(2):450-453.

Ashe, E., J. Wray, C. R. Picard, and R. Williams. 2013. Abundance and survival of Pacific humpback whales in a proposed critical habitat area. PLoS ONE 8(9):e75228.

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

Au, W., J. Darling, and K. Andrews. 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., J. Mobley, W. C. Burgess, M. O. Lammers, and P. E. Nachtigall. 2000a. Seasonal and diurnal trends of chorusing humpback whales wintering in waters off western Maui. Marine Mammal Science 16(3):15.

Au, W. W. L., and coauthors. 2006a. Acoustic properties of humpback whale songs. Journal of Acoustical Society of America 120(August 2006):1103-1110.

Au, W. W. L., and coauthors. 2006b. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America 120(2):1103.

Au, W. W. L., A. N. Popper, and R. R. Fay. 2000b. Hearing by whales and dolphins. Springer-Verlag, New York.

Bacon, C., M. A. Smultea, B. Würsig, K. Lomac-MacNair, and J. Black. 2011. Comparison of blue and fin whale behavior, headings and group characteristics in the southern California Bight during summer and fall 2008-2010. Pages 23 *in* 19th Biennial Confernce on the Biology of Marine Mammals, Tampa, Florida.

Baier, C. T., and J. M. Napp. 2003. Climate-induced variability in Calanus marshallae populations. Journal of Plankton Research 25:771-782.

Bailey, H., and coauthors. 2009. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. Endangered Species Research 10:93-106.

Baird, R. W., and S. K. Hooker. 2000. Ingestion of plastic and unusual prey by a juvenile harbour porpoise. Marine Pollution Bulletin 40(8):719-720.

Baird, R. W., A. D. Ligon, and S. K. Hooker. 2000. Sub-surface and night-time behavior of humpback whales off Maui, Hawaii: A preliminary report. Hawaiian Islands Humpback Whale National Marine Sanctuary.

Baker, C. S., and L. M. Herman. 1989. Behavioral responses of summering humpback whales to vessel traffic: Experimental and opportunistic observations. Kewalo Basin Marine Mammal Lab, Honolulu, Hawaii.

Baker, C. S., L. M. Herman, B. G. Bays, and G. B. Bauer. 1983a. 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.

Baker, C. S., L. M. Herman, W. Stifel, B. G. Bays, and A. Wolman. 1983b. The migratory movement of humpback whales between Hawaii and Alaska. Pages 5-6 *in* Fifth Biennial Conference on the Biology of Marine Mammals, New England Aquarium, Boston, Massachusetts.

Baker, C. S., A. Perry, and G. Vequist. 1988. Conservation update-- humpback whales of Glacier Bay, Alaska. Whalewatcher 22(3):13-17.

Baker, C. S., and coauthors. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Marine Ecology Progress Series 494:291-306.

Balcomb, K. C. 1987. The whales of Hawaii, including all species of marine mammals in Hawaiian and adjacent waters.Marine Mammal Fund Publication, San Francisco, CA. 99p.

Baldwin, R., and coauthors. 2010. Arabian Sea humpback whales: Canaries for the northern Indian Ocean? International Whaling Commission Scientific Committee, Agadir, Morocco.

Ban, S. 2005. Modelling, and characterization of Steller sea lion haulouts and rookeries using oceanographic and shoreline type data. Thesis. University of British Columbia, Vancouver, British Columbia.

Bando, T., and coauthors. 2010. Cruise Report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2009 (part I) - Offshore component. International Whaling Commission Scientific Committee.

Baracho-Neto, C. G., and coauthors. 2012. Site fidelity and residence times of humpback whales (*Megaptera novaeangliae*) on the Brazilian coast. Journal of the Marine Biological Association of the United Kingdom 92(8):1783-1791.

Baraff, L., and M. T. Weinrich. 1993. Separation of humpback whale mothers and calves on a feeding ground in early autumn. Marine Mammal Science 9(4):431-434.

Barendse, J., P. B. Best, I. Carvalho, and C. Pomilla. 2013. Mother knows best: Occurrence and associations of resighted humpback whales suggest maternally derived fidelity to a Southern Hemisphere coastal feeding ground. PLoS ONE 8(12):e81238.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fishery Bulletin 93:1-14.

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Admin. Rept. LJ-97- 11:Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 25p.

Barlow, J., and coauthors. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Marine Mammal Science 27(4):793-818.

Barlow, J., and coauthors. 1997. U.S. Pacific marine mammal stock assessment -1996. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, NMFS-SWFSC-248, La Jolla, California.

Barlow, J., and B. L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. Marine Mammal Science 21(3):429-445.

Bauer, G. B. 1986. The behavior of humpback whales in Hawaii and modifications of behavior induced by human interventions. University of Hawaii.

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

Baumgartner, M. F., and D. M. Fratantoni. 2008. Diel periodicity in both sei whale vocalization rates and the vertical migration of their copepod prey observed from ocean gliders. Limnology and Oceanography 53(5 Part 2):2197-2209.

Baumgartner, M. F., and coauthors. 2013. Associations between North Pacific right whales and their zooplanktonic prey in the southeastern Bering Sea. Marine Ecology Progress Series 490:267-284.

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

Baumgartner, M. F., and coauthors. 2008. Low frequency vocalizations attributed to sei whales (*Balaenoptera borealis*). Journal of the Acoustical Society of America 124(2):1339-1349.

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):217-221.

Benjamins, S., W. Ledwell, J. Huntington, and A. R. Davidson. 2012. Assessing changes in numbers and distribution of large whale entanglements in Newfoundland and Labrador, Canada. Marine Mammal Science 28(3):579-601.

Benson, S. R., D. A. Croll, B. B. Marinovic, F. P. Chavez, and J. T. Harvey. 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., D. L. Bradley, and T. B. Gabrielson. 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.

Bérubé, M., and coauthors. 1998. Population genetic structure of North Atlantic, Mediterranean and Sea of Cortez fin whales, *Balaenoptera physalus (*Linnaeus 1758): analysis of mitochondrial and nuclear loci. Molecular Ecology 7:585-599.

Berzin, A. A. 1971a. The sperm whale. Pacific Sci. Res. Inst. Fisheries Oceanography. Translation 1972, Israel Program for Scientific Translation No. 600707, Jerusalem: 1-394.

Berzin, A. A. 1971b. The sperm whale. (*Physeter macrocephalus*). Pishchevaya Promyshlennost Moscow, NTIS No. TT-71-50152.

Berzin, A. A. 1972. The sperm whale. Pacific Scientific Research Institute of Fisheries and Oceanography, Moscow. (Translated from Russian 1971 version by Israel Program for Scientific Translation, Jerusalem).

Berzin, A. A., and A. A. Rovnin. 1966. Distribution, and migration of whales in the northeastern part of the Pacific Ocean, Bering, and Chukchi seas. Izvestiya Tinro 58:179-207.

Berzin, A. A., and A. V. Yablokov. 1978. Abundance and population structure of important exploited cetacean species of the world ocean. Zoologichesky Zhurnal (12):1771-1785.

Best, P. B. 1987. Estimates of the landed catch of right (and other whalebone) whales in the American fishery, 1805-1909. Fishery Bulletin 85(3):403-418.

Best, P. B., J. Bannister, R. L. Brownell, and G. Donovan. 2001. Right whales: Worldwide status.

Best, P. B., and C. H. Lockyer. 2002. Reproduction, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa in the 1960s. South African Journal of Marine Science 24:111-133.

Best, P. B., P.A.S. Canham, and N. Macleod. 1984. Patterns of reproduction in sperm whales, *Physeter macrocephalus*. Report of the International Whaling Commission Special Issue 8:51-79.

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

Bickham, J. W., J. C. Patton, and T. R. Loughlin. 1996. High variability for control-region sequences in a marine mammal: Implications for conservation and biogeography of Steller sea lions (Eumetopias jubatus). Journal of Mammalogy 77:95-108.

Biedron, I. S., C. W. Clark, and F. Wenzel. 2005. Counter-calling in North Atlantic right whales (*Eubalaena glacialis*). Pages 35 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Biggs, D. C., R. R. Leben, and J. G. Ortega-Ortiz. 2000. Ship and satellite studies of mesoscale circulation and sperm whale habitats in the northeast Gulf of Mexico during GulfCet II. Gulf of Mexico Science 18(1):15-22.

Boebel, O., and coauthors. 2005. Risks posed to the Antarctic marine environment by acoustic instruments: A structured analysis. Antarctic Science 17(4):533-540.

Borrell, A. 1993. PCB and DDTs in blubber of cetaceans from the northeastern North Atlantic. Marine Pollution Bulletin 26(3):146.

Borrell, A., and A. Aguilar. 1987. Variations in DDE percentage correlated with total DDT burden in the blubber of fin and sei whales. Marine Pollution Bulletin 18:70-74.

Bort, J. E., S. Todd, P. Stevick, S. Van Parijs, and E. Summers. 2011. North Atlantic right whale (*Eubalaena glacialis*) acoustic activity on a potential wintering ground in the Central Gulf of Maine. Pages 38 *in* 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

Boyd, I. L., C. Lockyer, and H. D. Marsh. 1999. Reproduction in marine mammals. J. E. Reynolds III, and S. A. Rommel, editors. Biology of Marine Mammals. Smithsonian Institution Press, Washington, D.C.

Bradford, A. L., and K. A. Forney. 2013. Injury determinations for cetaceans observed interacting with Hawaii and American Samoa longline fisheries during 2007-2011. PIFSC Working Paper.

Bradford, A. L., and coauthors. 2003. Survival estimates of western gray whales (*Eschrichtius robustus*) incorporating individual heterogeneity and temporary emigration. International Whaling Commission Scientific Committee, Berlin.

Braham, H. W. 1991. Endangered whales: A status update. A report on the 5-year status of stocks review under the 1978 amendments to the U.S. Endangered Species Act. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Seattle, Washington.

Braham, H. W., and D. W. Rice. 1984. The right whale, *Balaena glacialis*. Marine Fisheries Review 46(4):38-44.

Branch, T. A., and Y. A. Mikhalev. 2008. Regional differences in length at sexual maturity for female blue whales based on recovered Soviet whaling data. Marine Mammal Science 24(3):690-703.

Brandon, R. 1978. Adaptation and evolutionary theory. Studies in the History and Philosophy of Science 9:181-206.

Brodie, P., and G. Vikingsson. 2009. On the feeding mechanisms of the sei whale (*Balaenoptera borealis*). Journal of Northwest Atlantic Fishery Science 42(5):49-54.

Brown, M. R., P. J. Corkeron, P. T. Hale, K. W. Schultz, and M. M. Bryden. 1994. Behavioral-Responses of East Australian Humpback Whales Megaptera-Novaeangliae to Biopsy Sampling. Marine Mammal Science 10(4):391-400.

Brown, M. W., S. D. Kraus, and D. E. Gaskin. 1991. Reaction of North Atlantic right whales (Eubalaena glacialis) to skin biopsy sampling for genetic and pollutant analysis. Report of the International Whaling Commission Special Issue 13:81-89.-Genetic Ecology of Whales and Dolphins).

Brownell Jr., R. L., P. J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. Journal of Cetacean Research and Management (Special Issue 2):269-286.

Brownell Jr., R. L., T. K. Yamada, J. G. Mead, and B. M. Allen. 2006. Mass strandings of melon-headed whales, *Peponocephala electra*: A worldwide review. International Whaling Commission Scientific Committee, St. Kitts and Nevis, West Indies.

Burdin, A. M., A. L. Bradford, G. A. Tsidulko, and M. Sidorenko. 2011. Status of western gray whales off northeastern Sakhalin Island and eastern Kamchatka, Russia in 2010. International Whaling Commission-Scientific Committee, Tromso, Norway.

Burdin, A. M., G. A. Tsidulko, M. Sidorenko, and E. Dzhikiya. 2010. Status of western gray whales off northeastern Sakhalin Island, Russia in 2009. International Whaling Commission Scientific Committee, Agadir, Morocco.

Burkhardt, E., O. Boebel, H. Bomemann, and C. Ruholl. 2007. Risk assessment of scientific sonars (poster). Alfred-Wegender-Institut, editor.

Burnell, S. R. 2001. Aspects of the reproductive biology, movements, and site fidelity of right whales off Australia. Journal of Cetacean Research and Management (Special issue) 2:89-102.

Burtenshaw, J. C., and coauthors. 2004. Acoustic and satellite remote sensing of blue whale seasonality and habitat in the Northeast Pacific. Deep Sea Research Part II: Topical Studies in Oceanography 51(10-11):967-986.

Calambokidis, J. 1997. The humpbacks of Costa Rica. Humpback whales and the California-Costa Rica connection. Whale-Journal of the Oceanic Society 1(1):4-7,10.

Calambokidis, J., J. Barlow, J. K. B. Ford, T. E. Chandler, and A. B. Douglas. 2009. Insights into the population structure of blue whales in the eastern North Pacific from recent sightings and photographic identification. Marine Mammal Science 25(4):816-832.

Calambokidis, J., E. Falcone, A. Douglas, L. Schlender, and J. Huggins. 2010. Photographic identification of humpback and blue whales off the U.S. West Coast: Results and updated abundance estimates from 2008 field season. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Calambokidis, J., and coauthors. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific U.S. Department of Commerce, Western Administrative Center, Seattle, Washington.

Calambokidis, J., and coauthors. 2003. Feeding and vocal behavior of blue whales determined through simultaneous visual-acoustic monitoring and deployment of suction-cap attached tags. Pages 27 *in* Abstracts of the 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, North Carolina.

Calambokidis, J., and coauthors. 1990. Sightings and movements of blue whales off central California 1986-88 from photo-identification of individuals. Report of the International Whaling Commission (Special Issue 12):343-348.

Calambokidis, J., G. H. Steiger, D. K. Ellifrit, B. L. Troutman, and C. E. Bowlby. 2004. Distribution and abundance of humpback whales (*Megaptera novaeangliae*) and other marine mammals off the northern Washington coast. Fishery Bulletin 102(4):563-580.

Calambokidis, J., and coauthors. 1996. Interchange and isolation of humpback whales off California and other North Pacific feeding grounds. Marine Mammal Science 12(2):215-226.

Calambokidis, J., and coauthors. 2001. Movements and population structure of humpback whales in the North Pacific. Marine Mammal Science 17(4):769-794.

Calambokidis, J., and coauthors. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Southwest Fisheries Science Center, 50ABNF500113, La Jolla, CA.

Calkins, D. G. 1986a. Marine Mammals. In The Gulf of Alaska, Physical Environment and Biological Resources:D.W. Hood and S.T. Zimmerman (editors), Government Printing Office, Washington, D.C. p.527−558.

Calkins, D. G. 1986b. Marine Mammals. Pages 527−558 *in* D. W. Hood, and S. T. Zimmerman, editors. In The Gulf of Alaska, Physical Environment and Biological Resources. Government Printing Office, Washington, D.C.

Call, K. A., and T. R. Loughlin. 2005. An ecological classification of Alaskan Steller sea lion (Eumetopias jubatus) rookeries: A tool for conservation/management. Fisheries and Oceanography 14:212-222.

Campbell, G. S., and coauthors. 2015. Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California. Deep Sea Research Part II: Topical Studies in Oceanography 112:143-157.

Canese, S., and coauthors. 2006. The first identified winter feeding ground of fin whales (Balaenoptera physalus) in the Mediterranean Sea. Journal of the Marine Biological Association of the United Kingdom 86(4):5.

Cantor, M., T. Cachuba, L. Fernandes, and M. H. Engel. 2010. Behavioural reactions of wintering humpback whales (*Megaptera novaeangliae*) to biopsy sampling in the western

South Atlantic. Journal of the Marine Biological Association of the United Kingdom 90(8):1701-1711.

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., and L. Enriquez. 2012. Marine mammal and seabird bycatch in California gillnet fisheries in 2010. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., and coauthors. 2007. U.S. Pacific marine mammal stock assessments: 2007.

Carretta, J. V., and coauthors. 2010. U. S. Pacific marine mammal stock assessments: 2009. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California.

Carretta, J. V., and coauthors. 2005. U.S. Pacific Marine Mammal Stock Assessments - 2004. .U.S. Department of Commerce, NOAA-TM-NMFS-SWFSC-375, 322p.

Carretta, J. V., and coauthors. 2006. U.S. Pacific Marine Mammal Stock Assessments: 2005. U.S. Department of Commerce NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-388. 325p.

Carretta, J. V., and coauthors. 2011. U.S. Pacific marine mammal stock assessments: 2010. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., and coauthors. 2012. U.S. Pacific marine mammal stock assessments: 2011.

Carretta, J. V., M. S. Lynn, and C. A. LeDuc. 1994. Right whale (Eubalaena glacialis) sighting off San Clemente Island, California. Marine Mammal Science 10(1):101-105.

Carretta, J. V., and coauthors. 2013a. U.S. Pacific marine mammal stock assessments: 2012. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., and coauthors. 2013b. U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2012. U.S. DEPARTMENT OF COMMERCE, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., and coauthors. 2014. U. S. Pacific marine mammal stock assessments, 2013. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Castellote, M., C. W. Clark, and M. O. Lammers. 2012. Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. Biological Conservation.

Cerchio, S. 2003. Paternity, polygyny and alternative mating tactics in humpback whales (Megaptera novaeangliae).. University of Michigan.

Cerchio, S., J. K. Jacobsen, D. M. Cholewiak, and E. A. Falcone. 2005. Reproduction of female humpback whales off the Revillagigedo Archipelago during a severe El Niño event. Pages 55 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

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., D. K. Mellinger, K. J. Dunsmore, K. M. Fristrup, and C. W. Clark. 2002. Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference. Marine Mammal Science 18(1):81-98.

Cherfas, J. 1989. The Hunting of the Whale. Viking Penguin Inc., New York, New York.

Christal, J., and H. Whitehead. 1997. Aggregations of mature male sperm whales on the Galápagos Islands breeding ground. Marine Mammal Science 13(1):59-69.

Christal, J., H. Whitehead, and E. Lettevall. 1998. Sperm whale social units: variation and change. Canadian Journal of Zoology 76:1431-1440.

Christensen, I., T. Haug, and N. Øien. 1992. A review of feeding, and reproduction in large baleen whales (Mysticeti) and sperm whales Physeter macrocephalus in Norwegian and adjacent waters. Fauna Norvegica Series A 13:39-48.

Christiansen, F., M. H. Rasmussen, and D. Lusseau. 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., and coauthors. 2004a. Distribution of north Pacific right whales (Eubalaena japonica) as shown by 19th, and 20th century whaling catch and sighting records. Journal of Cetacean Research and Management 6:1-6.

Clapham, P., K. Shelden, and P. Wade. 2005. Review of information relating to possible Critical Habitat for Eastern North Pacific right whales. Review of information relating to possible Critical Habitat for Eastern North Pacific right whales. NMML, NMFS, Seattle, Washington.

Clapham, P. J. 1994. Maturational changes in patterns of association among male and female humpback whales. Journal of Zoology 71:440-443.

Clapham, P. J. 1996. The social and reproductive biology of humpback whales: an ecological perspective. Mammal Review 26:27-49.

Clapham, P. J., and coauthors. 1993. Seasonal occurrence and annual return of humpback whales, Megaptera novaeangliae, in the southern Gulf of Maine. Canadian Journal of Zoology 71(2):440-443.

Clapham, P. J., and coauthors. 2004b. Distribution of North Pacific right whales (Eubalaena japonica) as shown by 19th and 20th century whaling catch and sighting records. Journal of Cetacean Research and Management 6(1):1-6.

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., and C. A. Mayo. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. Canadian Journal of Zoology 65:2853-2863.

Clapham, P. J., and C. A. Mayo. 1990. Reproduction of humpback whales (*Megaptera novaeangliae*) observed in the Gulf of Maine. Report of the International Whaling Commission Special Issue 12:171-175.

Clapham, P. J., S. B. Young, and R. L. Brownell Jr. 1999. Baleen whales: conservation issues and the status of the most endangered populations. Mammal Review 29(1):35-60.

Clark, C. 2006. Acoustic communication in the great whales: The medium and the message. Presentation at the 86th Annual Conference of the American Society of Mammalogists.

Clark, C. W., J. F. Borsani, and G. Notarbartolo-di-Sciara. 2002. Vocal activity of fin whales, *Balaenoptera physalus*, in the Ligurian Sea. Marine Mammal Science 18(1):286-295.

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.

Clarke, 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.

Clarke, M. R. 1976. Observation on sperm whale diving. Journal of the Marine Biology Association of the United Kingdom 56:809-810.

Clarke, M. R. 1977. Beaks, nets and numbers. Symposium of the Zoological Society of London 38:89-126.

Clarke, M. R. 1980a. Cephalopods in the diet of sperm whales of the Southern Hemisphere and their bearing on sperm whale biology. Discovery Reports 37.

Clarke, M. R. 1986. Cephalopods in the diet of odontocetes. Research on Dolphins. M. M. Bryden and R. J. Harrison (eds.). Oxford Univ. Press, Oxford, England. ISBN 0-19-857606-4. p.281-321.

Clarke, M. R. 1996. Cephalopods as prey. III. Cetaceans. Philosophical Transactions of the Royal Society of London B 351:1053-1065.

Clarke, M. R. 1997. Cephalopods in the stomach of a sperm whale stranded between the islands of Terschelling and Ameland, southern North Sea. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie 67-Suppl.:53-55.

Clarke, R. 1956. Sperm whales of the Azores. Discovery Reports 28:237-298.

Clarke, R. 1980b. Catches of sperm whales and whalebone whales in the southeast Pacific between 1908 and 1975. Report of the International Whaling Commission 30:285-288.

Cole, T. V. N., D. L. Hartley, and R. L. Merrick. 2005a. Mortality and serious injury determinations for large whales stocks along the eastern seaboard of the United States, 1999-2003. NOAA Northeast Fisheries Science Center 05-08.

Cole, T. V. N., D. L. Hartley, and R. L. Merrick. 2005b. Mortality and seriously injury determinations for North Atlantic Ocean large whale stocks 1999-2003. Northeast Fisheries Science Center Reference Document 05-08:U.S. Department of Commerce, NOAA, National Marine Fisheries Service Northeast Fisheries Science Center. Woods Hole, MA. 18p.

Commission, I. W. 2004. Report of the Workshop on the Western Gray Whale: Research and Monitoring Needs, 22-25 October 2002, Ulsan, Korea. Journal of Cetacean Research And Management 6(Supplement):487-500.

Conway, C. A. 2005. Global population structure of blue whales, *Balaenoptera musculus* spp., based on nuclear genetic variation. University of California, Davis.

Cooke, J., D. W. Weller, A. L. Bradford, A. M. Burdin, and J. R. L. Brownell. 2005. Estimates and projections of the western gray whale population using an individuallybased population model. Unpublished paper to the IWC Scientific Committee. 14 pp. Ulsan, Korea, June (SC/57/BRG22).

Cooke, J. G., V. J. Rowntree, and R. Payne. 2001. Estimates of demographic parameters for southern right whales (Eubalaena australis) observed off Península Valdés, Argentina. Journal of Cetacean Research and Management (Special Issue) 2:125-132.

Cooke, J. G., D. W. Weller, A. L. Bradford, A. M. Burdin, and R. L. Brownell. 2008. Population assessment of western gray whales in 2008. IWC Scientific Committee, Santiago, Chile.

Corkeron, P., P. Ensor, and K. Matsuoka. 1999. Observations of blue whales feeding in Antarctic waters. Polar Biology 22:213-215.

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.

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

COSEWIC. 2005. COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* (Pacific population, Atlantic population) in Canada. COSEWIC, Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 37p. Available at: www.sararegistry.gc.ca/status/status_e.cfm.

COSEWIC. 2011. COSEWIC assessment and status report on the humpback whale *Megaptera novaeangliae* North Pacific population in Canada. COSEWIC Committee on the Status of Endangered Wildlife in Canada.

Cotte, C., C. Guinet, I. Taupier-Letage, B. Mate, and E. Petiau. 2009. Scale-dependent habitat use by a large free-ranging predator, the Mediterranean fin whale. Deep Sea Research Part I: Oceanographic Research Papers 56(5)801-811.

Coughran, D. K., N. J. Gales, and H. C. Smith. 2013. A note on the spike in recorded mortality of humpback whales (*Megaptera novaeangliae*) in Western Australia. Journal of Cetacean Research and Management 13(2):105-108.

Cranford, T. W. 1992. Functional morphology of the odontocete forehead: implications for sound generation. University of California at Santa Cruz, Santa Cruz, California.

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., and coauthors. 1999a. From wind to whales: Foraging ecology of rorquals in the California Current. Thirteen Biennial Conference on the Biology of Marine Mammals, 28 November - 3 December Wailea Maui HI. p.41.

Croll, D. A., A. Acevedo-Gutierrez, B. R. Tershy, and J. Urban-Ramirez. 2001a. The diving behavior of blue and fin whales: is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology a-Molecular & Integrative Physiology 129(4):797-809.

Croll, D. A., and coauthors. 2002. Only male fin whales sing loud songs. Nature 417:809.

Croll, D. A., C. W. Clark, J. Calambokidis, W. T. Ellison, and B. R. Tershy. 2001b. Effect of anthropogenic low-frequency noise on the foraging ecology of *Balaenoptera* whales. Animal Conservation 4(1):13-27.

Croll, D. A., C. W. Clark, J. Calambokidis, W. T. Ellison, and B. R. Tershy. 2001c. Effect of anthropogenic low-frequency noise on the foraging ecology of Balaenoptera whales. Animal Conservation 4(1):13-27.

Croll, D. A., B. R. Tershy, A. Acevedo, and P. Levin. 1999b. 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. 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.

D'Vincent, C. G., R. M. Nilson, and R. E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Scientific Reports of the Whales Research Institute 36:41-47.

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. Pages 67 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Danilewicz, D., M. Tavares, I. B. Moreno, P. H. Ott, and C. C. Trigo. 2009. Evidence of feeding by the humpback whale (Megaptera novaeangliae) in mid-latitude waters of the western South Atlantic. JMBA2 - Biodiversity Records-Published Online 3Pgs.

Darling, J. D., and S. Cerchio. 1993. Movement of a Humpback Whale (Megaptera-Novaeangliae) between Japan and Hawaii. Marine Mammal Science 9(1):84-89.

Davis, R. W., W. E. Evans, and B. Würsig. 2000. Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Minerals Management Service, New Orleans, Louisiana.

Davis, R. W., and coauthors. 2007. Diving behavior of sperm whales in relation to behavior of a major prey species, the jumbo squid, in the Gulf of California, Mexico. Marine Ecology Progress Series 333:291-302.

Davis, R. W., and coauthors. 2002. Cetacean habitat in the northern oceanic Gulf of Mexico. Deep Sea Research Part I: Oceanographic Research Papers 49(1):121-142.

de Stephanis, R., J. Giménez, E. Carpinelli, C. Gutierrez-Exposito, and A. Cañadas. 2013. As main meal for sperm whales: Plastics debris. Marine Pollution Bulletin.

De Vos, A., T. Wu, and R. L. Brownell Jr. 2013. Recent blue whale deaths due to ship strikes around Sri Lanka. IWC Scientific Committee, Jeju, Korea.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-83: Status, abundance, and distribution.Final Report to the Minerals Management Service, Contract No. 14-12-0001-29090. 284p.

Dolphin, W. F. 1987. Ventilation and dive patterns of humpback whales, *Megaptera novaeangliae*, on their Alaskan feeding grounds. Canadian Journal of Zoology 65(1):83-90.

DoN. 2013. Mariana Islands training and testing environmental impact statement/overseas environmental impact statement. Department of the Navy.

Doney, S. C., and coauthors. 2012. Climate change impacts on marine ecosystems. Marine Science 4.

Donovan, G. P. 1991. A review of IWC stock boundaries. Report of the International Whaling Commission (Special Issue 13).

Doroshenko, N. V. 2000. Soviet whaling for blue, gray, bowhead, and right whales in the North Pacific Ocean, 1961-1979. Pages 96-103 *in* Soviet Whaling Data (1949-1979). Center for Russian Environmental Policy Marine Mammal Council, Moscow.

Douglas, A. B., and coauthors. 2008. Incidence of ship strikes of large whales in Washington State. Journal of the Marine Biological Association of the United Kingdom.

Dragoset, B. 2000. Introduction to air guns and air-gun arrays. Leading Edge 19(8):892-897.

Dufault, S., H. Whitehead, and M. Dillon. 1999. An examination of the current knowledge on the stock structure of sperm whales (*Physeter macrocephalus*) worldwide. Journal of Cetacean Research and Management 1(1):1-10.

Dunlop, R. A., D. H. Cato, and M. J. Noad. 2008. Non-song acoustic communication in migrating humpback whales (Megaptera novaeangliae). Marine Mammal Science 24(3):613-629.

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.

Eldredge, L. G. 1991. Annotated checklist of the marine mammals of Micronesia. Micronesica 24(2):217-230.

Eldredge, L. G. 2003. The marine reptiles and mammals of Guam. Micronesica 35(36):653-660.

Elfes, C. T., and coauthors. 2010. Geographic variation of persistent organic pollutant levels in humpback whale (Megaptera novaeangliae) feeding areas of the North Pacific and North Atlantic. Environmental Toxicology and Chemistry 29(4):824-834.

Elvin, S. S., and C. T. Hogart. 2008. Right whales and vessels in Canadian waters. Marine Policy 32(3):379-386.

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

Erbe, C. 2002b. 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.

Evans, K., M. A. Hindell, and G. Hince. 2004. Concentrations of organochlorines in sperm whales (Physeter macrocephalus) from Southern Australian waters. Marine Pollution Bulletin 48:486-503.

Fadely, B. S., B. W. Robson, J. T. Sterling, A. Greig, and K. A. Call. 2005. Immature Steller sea lion (Eumetopias jubatus) dive activity in relation to habitat features of the eastern Aleutian Islands. Fisheries Oceanography 14(Supplement 1:243-258.

Fearnbach, H., J. W. Durhan, S. A. Mizroch, S. Barbeaux, and P. R. Wade. 2012. Winter observations of a group of female and immature sperm whales in the high-latitude waters near the Aleutian Islands, Alaska. Marine Biodiversity Records 5: e13.

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

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

Félix, F. 2001. Observed changes of behavior in humpback whales during whalewatching encounters off Ecuador. 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada.

Fiedler, P. C., and coauthors. 1998. Blue whale habitat and prey in the California Channel Islands. Deep-Sea Research Part Ii-Topical Studies in Oceanography 45(8-9):1781-1801.

Findlay, K. P., and P. B. Best. 1995. Summer incidence of humpback whales on the west coast of South Africa. (Megaptera novaeangliae). South African Journal of Marine Science 15:279-282.

Fischer, J. B. 1829. Synopsis Mammalium. J.G. Cottae, Stuttgart.

Ford, J. K. B., and coauthors. 2009. An assessment of the potential for recovery of humpback whales off the Pacific Coast of Canada.

Ford, J. K. B., and R. R. Reeves. 2008. Fight or flight: antipredator strategies of baleen whales. Mammal Review 38(1):50-86.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fishery Bulletin 93:15-26.

Forney, K. A., and R. L. Brownell Jr. 1996a. Preliminary report of the 1994 Aleutian Island marine mammal survey. Paper SC/48/011 presented to the IWC Scientific Committee, June 1996 (unpublished). NOAA Fisheries Southwest Fisheries Science Center, La Jolla, California.

Forney, K. A., and R. L. Brownell Jr. 1996b. Preliminary report of the 1994 Aleutian Island marine mammal survey. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Paper SC/48/011, La Jolla, California.

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.

Friedlaender, A. S., R. B. Tyson, A. K. Stimpert, A. J. Read, and D. P. Nowacek. 2013. Extreme diel variation in the feeding behavior of humpback whales along the western Antarctic Peninsula during autumn. Marine Ecology Progress Series 494:281-289.

Fritz, L., and coauthors. 2013. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) conducted in Alaska in June-July 2008 through 2012, and an ppdate on the status and trend of the Western Distinct population segment in Alaska. NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center.

Fulling, G. L., P. H. Thorson, and J. Rivers. 2011. Distribution and abundance estimates for cetaceans in the waters off Guam and the Commonwealth of the Northern Mariana Islands. Pacific Science 65(3):321-343.

Futuymda, D. J. 1986. Evolutionary biology, Second ed. edition. Sinauer

Associates, Inc., Sunderland, Massachussetts.

Gabriele, C., B. Kipple, and C. Erbe. 2003. Underwater acoustic monitoring and estimated effects of vessel noise on humpback whales in Glacier Bay, Alaska. Pages 56-57 *in* Fifteenth Biennial Conference on the Biology of Marine Mammals, Greensboro, North Carolina.

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.

Gabriele, C. M., J. M. Straley, and J. L. Neilson. 2007. Age at first calving of female humpback whales in southeastern Alaska. Marine Mammal Science 23(1):226-239.

Gambell, R. 1976. World whale stocks. Mammal Review 6(1):41-53.

Gambell, R. 1985a. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). Pages 171-192 *in* Handbook of Marine Mammals, volume 3: The Sirenians and Baleen Whales. Academic Press, London, United Kingdom.

Gambell, R. 1985b. Sei whale, *Balaenoptera borealis* Lesson, 1828. Pages 155-170 *in* S. H. Ridway, and S. R. Harrison, editors. Handbook of Marine Mammals, volume 3: The Sirenians and Baleen Whales. Academic Press, London.

Garcia-Godos, I., K. V. Waerebeek, J. Alfaro-Shigueto, and J. C. Mangel. 2013. Entanglements of large cetaceans in Peru: Few records but high risk. Pacific Science 67(4):523-532.

Gaskin, D. E. 1972. Whales, dolphins, and seals; with special reference to the New Zealand region.Heinemann, London. 200 pp.

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

Gauthier, J. M., C. D. Metcalfe, and R. Sears. 1997. Chlorinated organic contaminants in blubber biopsies from Northwestern Atlantic Balaenopterid whales summering in the Gulf of St Lawrence. Marine Environmental Research 44(2):201-223.

Gendron, D., and J. Urban. 1993. Evidence of feeding by humpback whales (Megaptera novaeangliae) in the Baja California breeding ground, Mexico. Marine Mammal Science 9:76-81.

Gero, S., D. Engelhaupt, L. Rendell, and H. Whitehead. 2009. Who cares? Between-group variation in alloparental caregiving in sperm whales. Behavioral Ecology.

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

Gilpatrick, J., James W., and W. L. Perryman. 2009. Geographic variation in external morphology of North Pacific and Southern Hemisphere blue whales (Balaenoptera musculus). Journal of Cetacean Research and Management 10(1):9-21.

Gilpatrick, J. W., Jr., W. L. Perryman, J. R. L. Brownell, M. S. Lynn, and M. L. Deangelis. 1997. Geographical variation in North Pacific and Southern Hemisphere blue whales (Balaenoptera musculus). Unpublished paper to the IWC Scientific Committee. 33 pp. Bournemouth, September (SC/49/O9).

Glockner-Ferrari, D. A., and M. J. Ferrari. 1985. Individual identification, behavior, reproduction, and distribution of humpback whales, Megaptera novaeangliae, in Hawaii. U.S. Marine Mammal Commission, Washington, D.C.; National Technical Information Service, Springfield, Virginia: 36p.

Glockner, D. A., and S. C. Venus. 1983. Identification, growth rate, and behavior of humpback whale (*Megaptera novaeangliae*) cows and calves in the waters off Maui, Hawaii, 1977-79. Pages 223-258 *in* R. Payne, editor. Communication and Behavior of Whales. Westview Press, Boulder, CO.

Goddard, P. C., and D. J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Marine Mammal Science 14(2):344-349.

Goldbogen, J. A., and coauthors. 2013. Blue whales respond to simulated mid-frequency military sonar. Proceedings of the Royal Society of London Series B Biological Sciences 280(1765):Article 20130657.

Goodyear, J. 1989. Continuous-transmitting depth of dive tag for deployment and use of free swimming whales. Pages 23 *in* Eighth Biennial Conference on the Biology of Marine Mammals, Asilomar Conference Center, Pacific Grove, California.

Goodyear, J. D. 1983. Night behavior of humpback whales in the Gulf of Maine as determined by radio tracking. Pages 38-39 *in* Fifth Biennial Conference on the Biology of Marine Mammals, New England Aquarium, Boston, Massachusetts.

Goodyear, J. D. 1993. A sonic/radio tag for monitoring dive depths and underwater movements of whales. Journal of Wildlife Management 57(3):503-513.

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., H. Whitehead, and R. J. Reid. 2002. North Atlantic Sperm Whale, *Physeter macrocephalus*, strandings on the coastlines of the British Isles and Eastern Canada. Canadian Field-Naturalist 116:371-388.

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.

Gordon, J., and coauthors. 2004. A review of the effects of seismic surveys on marine mammals. Mar. Technol. Soc. J. 37(4):16-34.

Gordon, J. C. D. 1987. Sperm whale groups and social behaviour observed off Sri Lanka. Report of the International Whaling Commission 37:205-217.

Gosho, M. E., D. W. Rice, and J. M. Breiwick. 1984. The sperm whale, *Physeter macrocephalus*. Marine Fisheries Review 46(4):54-64.

Gray, J. E. 1865. Dr. H. Burmeister on a new whale. (Balaenoptera patachonica). Proceedings of the Zoological Society of London 33(1):190-195.

Green, G. A., and coauthors. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Green, M. L., and R. G. Green. 1990. Short-term impact of vessel traffic on the Hawaiian humpback whale (*Megaptera novaeangliae*). Pages 4 *in* Annual Meeting of the Animal Behavior Society. Ocean Mammal Institute, SUNew York, Buffalo, New York.

Gregr, E. J., and K. O. Coyle. 2009. The biogeography of the North Pacific right whale (Eubalaena japonica). Progress in Oceanography 20-Mar(4-Mar):188-198.

Gregr, E. J., L. Nichol, J. K. B. Ford, G. Ellis, and A. W. Trites. 2000. Migration and population structure of northeastern Pacific whales off coastal British Columbia: An analysis of commercial whaling records from 1908-1967. Marine Mammal Science 16(4):699-727.

Gregr, E. J., and A. W. Trites. 2001. Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 58(7):1265-1285.

Griffin, R. B. 1999. Sperm whale distributions and community ecology associated with a warm-core ring off Georges Bank. Marine Mammal Science 15(1):33-51.

Gunnlaugsson, T., G. A. Vikingsson, and S. D. Halldorsson. 2013. Recent changes in biological parameters of North Atlantic fin whales. IWC Scientific Committee, Jeju, Korea.

Guzman, H. M., C. G. Gomez, C. A. Guevara, and L. Kleivane. 2013. Potential vessel collisions with Southern Hemisphere humpback whales wintering off Pacific Panama. Marine Mammal Science 29(4):629–642.

Hain, J. H. W., G. R. Carter, S. D. Kraus, C. A. Mayo, and H. E. Winn. 1982. Feeding behavior of the humpback whale, *Megaptera novaeangliae,* in the western North Atlantic. Fishery Bulletin 80(2):259-268.

Hain, J. H. W., and coauthors. 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. Marine Mammal Science 11(4):464-479.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985a. The role of cetaceans in the shelf-edge region of the Northeastern United States. Marine Fisheries Review 47(1):13-17.

Hain, J. H. W., W. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985b. The role of cetaceans in the shelf-edge region of the U.S. Marine Fisheries Review 47(1):13-17.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Report of the International Whaling Commission 42:653-669.

Hall, J. D. 1982. Prince William Sound, Alaska: Humpback whale population and vessel traffic study. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Juneau Management Office, Contract No. 81-ABG-00265., Juneau, Alaska.

Hamilton, P. K., G. S. Stone, and S. M. Martin. 1997. Note on a deep humpback whale (*Megaptera novaeangliae*) dive near Bermuda. Bulletin of Marine Science 61:491-494.

Harwood, L. A., and I. Stirling. 1987. Patterns of aggregation in ringed seals, bearded seals and bowhead whales in the Beaufort Sea during late summer. Seventh Biennial Conference on the Biology of Marine Mammals, 5-9 December Miami Florida. p.29.

Hashagen, K. A., G. A. Green, and B. Adams. 2009. Observations of humpback whales, Megaptera novaeangliae, in the Beaufort Sea, Alaska. Northwestern Naturalist 90(2):160-162.

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

Hazen, E. L., and coauthors. 2012. Predicted habitat shifts of Pacific top predators in a changing climate. Nature Climate Change Letters.

HDR. 2012. Summary Report: Compilation of Visual Survey Effort and Sightings for Marine Species Monitoring in the Hawaii Range Complex, 2005-2012. Commander, U.S. Pacific Fleet, N62470-10-D-3011, Pearl Harbor, Hawaii.

Helweg, D. A., A. S. Frankel, J. Joseph R. Mobley, and L. M. Herman. 1992. Humpback whale song: Our current understanding. Pages 459-483 *in* J. A. Thomas, R. A. Kastelein, and A. Y. Supin, editors. Marine Mammal Sensory Systems. Plenum Press, New York.

Hendrix, A. N., J. Straley, C. M. Gabriele, and S. M. Gende. 2012. Bayesian estimation of humpback whale (*Megaptera novaeangliae*) population abundance and movement patterns in southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences 69(11):1783-1797.

Henry, J., and P. B. Best. 1983. Organochlorine residues in whales landed at Durban, South Africa. Marine Pollution Bulletin 14(6):223-227.

Herman, L. M. 1979. Humpback whales in Hawaiian waters: A study in historical ecology. Pacific Science 33(1):1-16.

Herman, L. M., C. S. Baker, P. H. Forestell, and R. C. Antinoja. 1980. Right whale, Balaena glacialis, sightings near Hawaii: A clue to the wintering grounds? Marine Ecology Progress Series 2:271-275.

Herman, L. M., and coauthors. 2011. Resightings of humpback whales in Hawaiian waters over spans of 10–32 years: Site fidelity, sex ratios, calving rates, female demographics, and the dynamics of social and behavioral roles of individuals. Marine Mammal Science.

Hildebrand, J. 2005. Impacts of anthropogenic sound. Pages 101-123 *in* J. E. Reynolds III, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen, editors. Marine Mammal Research: Conservation Beyond Crisis. Johns Hopkins University Press, Baltimore.

Hildebrand, J. A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395:5-20.

Hildebrand, J. A., and coauthors. 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.

Hill, P. S., and D. P. Demaster. 1998. Alaska marine mammal stock assessments, 1998. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Hill, P. S., and D. P. DeMaster. 1999. Alaska Marine Mammal Stock Assessments - 1999. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-110.:Alaska Fisheries Science Center; Auke Bay, Alaska. 177p.

Hill, P. S., D. P. Demaster, and R. J. Small. 1997. Alaska marine mammal stock assessments, 1996. National Marine Fisheries Service.

Holt, M. M., D. P. Noren, V. Veirs, C. K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America 125(1):El27-El32.

Hooker, S. K., R. W. Baird, S. Al-Omari, S. Gowans, and H. Whitehead. 2001. Behavioral reactions of northern bottlenose whales (*Hyperoodon ampullatus*) to biopsy darting and tag attachment procedures. Fishery Bulletin 99(2):303-308.

Horwood, J. 1987. The Sei Whale: Population Biology, Ecology and Management. Croom Helm, London, England.

Horwood, J. 2009. Sei whale: *Balaenoptera borealis*. Pages 1001-1003 *in* W. F. Perrin, B. Wursig, and J. G. M. Thewissen, editors. Encyclopedia of Marine Mammals, Second edition. Academic Press, San Diego.

Hotchkin, C. F., S. E. Parks, and C. W. Clark. 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. Pages 136 *in* Nineteenth Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

Hucke-Gaete, R., L. Osman, C. Moreno, K. P. Findlay, and D. Ljungblad. 2004. Discovery of a blue whale feeding and nursing ground in southern Chile. Proceedings of the Royal Society of London, Series B: Biological Sciences 271(Suppl.):S170-S173.

Ichihara, T. 1966. The pygmy blue whale, Balaenoptera musculus brevicauda, a new subspecies from the Antarctic. Whales, Dolphins and Porpoises. K. S. Norris (ed.). University of California Press, Berkeley, CA. p.79-113.

Ilangakoon, A. D. 2012. Exploring anthropogenic activities that threaten endangered blue whales (*Balaenoptera musculus)* off Sri Lanka. Journal of Marine Animals and their Ecology 5(1):3-7.

IPCC. 2014. Climate change 2014: Impacts, adaptation, and vulnerability. IPCC Working Group II contribution to AR5. Intergovernmental Panel on Climate Change.

IUCN. 2010. IUCN Red List of Threatened Species. Version 2010.4.

Ivashchenko, Y. V., R. L. Brownell Jr., and P. J. Clapham. 2014. Distribution of Soviet catches of sperm whales *Physeter macrocephalus* in the North Pacific. Endangered Species Research 25(3):249-263.

Ivashchenko, Y. V., and P. J. Clapham. 2012. Soviet catches of right whales *Eubalaena japonica* and bowhead whales *Balaena mysticetus* in the North Pacific Ocean and the Okhotsk Sea. Endangered Species Research 18(3):201-217.

Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell Jr. 2013. Soviet catches of whales in the North Pacific: Revised totals. Journal of Cetacean Research and Management 13(1):59–71.

Ivashin, M. V., and A. A. Rovnin. 1967. Some results of the Soviet whale marking in the waters of the North Pacific. Norsk Hvalfangst-Tidende 56(6):123-135.

IWC. 1980. Sperm Whales. Report of the International Whaling Commission (Special Issue 2):245p.

IWC. 1991. Report of the ad-hoc working group on the effect of biopsy sampling on individual cetaceans. Report of the International Whaling Commission Special Issue 13:23-28.

IWC. 2001. Report of the workshop on the comprehensive assessment of right whales: A worldwide comparison. Journal of Cetacean Research, and Management (Special issue) 2:1-56.

IWC. 2003. Report of the workshop on the western gray whale: Research and monitoring needs. International Whaling Commission.

IWC. 2005. Chair's Report of the 57th Annual Meeting. International Whaling Commission. Available online at: http://www.iwcoffice.org/_documents/meetings/ulsan/CRREP57.pdf Accessed 7/26/2006.

IWC. 2006. Scientific permit whaling: Information on scientific permits, review procedure guidelines, and current permits in effect. International Whaling Commission, http://www.iwcoffice.org/conservation/permits.htm Accessed: 3/14/2007.

IWC. 2008. Catch limits & catches taken. International Whaling Commission.

IWC. 2012. Extracts from the IWC64 Scientific Committee report relevant to the WGWAP. International Whaling Commission.

Jacobsen, J. K., L. Massey, and F. Gulland. 2010. Fatal ingestion of floating net debris by two sperm whales (*Physeter macrocephalus*). Marine Pollution Bulletin 60(5):765-767.

Jahoda, M., and coauthors. 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.

Jaquet, N., and D. Gendron. 2009. The social organization of sperm whales in the Gulf of California and comparisons with other populations. Journal of the Marine Biological Association of the United Kingdom 89(05):975.

Jaquet, N., and H. Whitehead. 1996. Scale-dependent correlation of sperm whales distribution with environmental features and productivity in the South Pacific. Marine Ecology Progress Series 135:1-9.

Jaquet, N., H. Whitehead, and M. Lewis. 1996. Coherence between 19th century sperm whale distributions and satellite-derived pigments in the tropical Pacific. Marine Ecology Progress Series 145:1-10.

Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler. 2005. Sounding the depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life. Natural Resources Defense Council, New York, New York.

Jefferson, T. A., and B. E. Curry. 1996. Acoustic methods of reducing or eliminating marine mammal-fishery interactions: Do they work? Ocean and Coastal Management 31(1):41-70.

Jefferson, T. A., M. A. Webber, and R. L. Pitman. 2008. Marine Mammals of the World: A Comprehensive Guide to their Identification. Academic Press, Elsevier. London, U.K.

Jefferson, T. A. P. J. S., and R. W. Baird. 1991. A review of killer whale interactions with other marine mammals: Predation to co-existence. Mammal Review 21:151-180.

Jensen, A., M. Williams, L. Jemison, and K. Raum-Suryan. 2009. Somebody untangle me! Taking a closer look at marine mammal entanglement in marine debris. Alaska Sea Grant Report.

Jensen, A. S., and G. K. Silber. 2003. Large whale ship strike database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR.

Jensen, A. S., and G. K. Silber. 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR. 37p. Available at: http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/lwssdata.pdf.

Jochens, A., and coauthors. 2006. Sperm whale seismic study in the Gulf of Mexico; Summary Report 2002-2004. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-034. 352p.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Marine Fisheries Review 46(4):30-37.

Johnson, M. P., and P. L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE Journal of Oceanic Engineering 28(1):3-12.

Josephson, E., T. D. Smith, and R. R. Reeves. 2008. Historical distribution of right whales in the North Pacific. Fish and Fisheries 9(2):155-168.

Jurasz, C. M., and V. Jurasz. 1979. Feeding modes of the humpback whale, Megaptera novaeangliae, in southeast Alaska. Scientific Reports of the Whales Research Institute, Tokyo 31:69-83.

Kasuya, T. 1991. Density dependent growth in North Pacific sperm whales. Marine Mammal Science 7(3):230-257.

Kasuya, T., and T. Miyashita. 1988. Distribution of sperm whale stocks in the North Pacific. Scientific Reports of the Whales Research Institute, Tokyo 39:31-75.

Kato, H., T. Miyashita, and H. Shimada. 1995. Segregation of the two sub-species of the blue whale in the Southern Hemisphere. (Balanenoptera musculus). Report of the International Whaling Commission 45:273-283.-Sc/46/Sh10).

Katona, S. K., and H. P. Whitehead. 1981. Identifying humpback whales using their natural markings. (*Megaptera novaeangliae*). Polar Record 20(128):439-444.

Kaufman, G. D., and M. Osmond. 1987. Aspects of population dynamics of East Australian humpback whales. Seventh Biennial Conference on the Biology of Marine Mammals, 5-9 December Miami Florida. p.36.

Kawamura, A. 1974. Food and feeding ecology of the southern sei whale. Scientific Reports of the Whales Research Institute, Tokyo 26:25-144.

Kawamura, A. 1980. A review of food of balaenopterid whales. Scientific Reports of the Whales Research Institute 32:155-197.

Kawamura, A. 1982a. Food habits and prey distributions of three rorqual species in the North Pacific Ocean. Scientific Reports of the Whales Research Institute, Tokyo 34:59-91.

Kawamura, A. 1982b. A review of food of balaenopterid whales. Scientific Report to the Whales Research Institute 32:155–197.

Kennedy, A. S., D. R. Salden, and P. J. Clapham. 2012. First high- to low-latitude match of an eastern North Pacific right whale (*Eubalaena japonica*). Marine Mammal Science 28(4):E539-E544.

Kennedy, A. S., and coauthors. 2013. Local and migratory movements of humpback whales (*Megaptera novaeangliae*) satellite-tracked in the North Atlantic Ocean. Canadian Journal of Zoology:8-17.

Kenney, R. D. 2001. Anomalous 1992 spring and summer right whale (Eubalaena glacialis) distributions in the Gulf of Maine. Journal of Cetacean Research and Management Special Issue 2:209-223.

Kenney, R. D. 2002. North Atlantic, North Pacific, and southern right whales. Pages 806-813 *in* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, California.

Kenney, R. D., M. A. M. Hyman, and H. E. Winn. 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States Outer Continental Shelf. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/NEC-41.

Kenney, R. D., and H. E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. Continental Shelf Research 7(2):107-114.

Ketten, D. R. 1992. The cetacean ear: Form, frequency, and evolution. Pages 53-75 *in* J. A. Thomas, R. A. Kastelein, and A. Y. Supin, editors. Marine Mammal Sensory Systems. Plenum Press, New York.

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. U.S. Department of Commerce, NOAA-TM-NMFS-SWFSC-256.

Ketten, D. R., and D. C. Mountain. 2014. Inner ear frequency maps: First stage audiograms of low to infrasonic hearing in mysticetes. Pages 41 *in* Fifth International Meeting on the Effects of Sounds in the Ocean on Marine Mammals (ESOMM - 2014), Amsterdam, The Netherlands.

Kipple, B., and C. Gabriele. 2004. Underwater noise from skiffs to ships. J. F. Piatt, and S. M. Gende, editors. Fourth Glacier Bay Science Symposium.

Kirkwood, G. P. 1992. Background to the development of revised management procedures, Annex I. Report of the International Whaling Commission 42:236-239.

Kjeld, M., O. Olafsson, G. A. Vikingsson, and J. Sigurjonsson. 2006. Sex Hormones and Reproductive Status of the North Atlantic Fin Whales (Balaenoptera physalus) During the Feeding Season. Aquatic Mammals 32(1):75-84.

Klumov, S. K. 1962. The right whales in the Pacific Ocean. Trudy Instituta Okeanologii 58:202–297.

Knowlton, A., C. W. Clark, and S. Kraus. 1991. Sounds recorded in the presence of sei whale, *Balaenoptera borealis*. Acoustical Society of America.

Knowlton, A. R., S. D. Kraus, and R. D. Kenney. 1994. Reproduction in North Atlantic right whales (Eubalaena glacialis). Canadian Journal of Zoology 72(7):1297-1305.

Konishi, K., and coauthors. 2009. Feeding strategies and prey consumption of three baleen whale species within the Kuroshio-Current Extension. Journal of Northwest Atlantic Fishery Science 42(Article No.3):27-40.

Kragh Boye, T., M. Simon, and P. T. Madsen. 2010. Habitat use of humpback whales in Godthaabsfjord, West Greenland, with implications for commercial exploitation. Journal of the Marine Biological Association of the United Kingdom 90(8):1529-1538.

Kremser, U., P. Klemm, and W. D. Kotz. 2005. Estimating the risk of temporary acoustic threshold shift, caused by hydroacoustic devices, in whales in the Southern Ocean. Antarctic Science 17(1):3-10.

Krieger, K. J., and B. L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, summer 1983. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Center.

Ladrón De Guevara, P. P., B. E. Lavaniegos, and G. Heckel. 2008. Fin whales (Balaenoptera physalus) foraging on daytime surface swarms of the euphausiid Nyctiphanes simplex in Ballenas Channel, Gulf of California, Mexico. Journal of Mammalogy 89(32):559-566.

Lafortuna, C. L., M. Jahada, A. Azzellino, F. Saibene, and A. Colombini. 2003. Locomotor behaviours and respiratory pattern of the Mediterranean fin whale (Balaenoptera physalus). European Journal of Applied Physiology 90:387-395.

Lafortuna, C. L., and coauthors. 1999. Locomotor behaviour and respiratory patterns in Mediterranean fin whales (Balaenoptera physalus) tracked in their summer feeding ground. Pages 156-160 *in* P. G. H. Evan, and E. C. M. Parsons, editors. Proceedings of the Twelfth Annual Conference of the European Cetacean Society, Monaco.

Lagerquist, B. A., K. M. Stafford, and B. R. Mate. 2000. Dive characteristics of satellite-monitored blue whales (*Balaenoptera musculus*) off the Central California coast. Marine Mammal Science 16(2):375-391.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1):35-75.

Lambert, E., C. Hunter, G. J. Pierce, and C. D. MacLeod. 2010. Sustainable whale-watching tourism and climate change: towards a framework of resilience. Journal of Sustainable Tourism 18(3):409-427.

Lambertsen, R. H. 1986. Disease of the common fin whale (*Balaenoptera physalus*): Crassicaudiosis of the urinary system. Journal of Mammalogy 67(2):353-366.

Lambertsen, R. H. 1990. Disease biomarkers in large whale populations of the North Atlantic and other oceans. Pages 395-417 *in* J. E. Mccarthy, and L. R. Shugart, editors. Biomarkers of Environmental Contamination. Lewis Publishers, Boca Raton, Florida.

Lambertsen, R. H. 1992. Crassicaudosis: a parasitic disease threatening the health and population recovery of large baleen whales. Rev. Sci. Technol., Off. Int. Epizoot. 11(4):1131-1141.

Lambertsen, R. H., B. A. Kohn, J. P. Sundberg, and C. D. Buergelt. 1987. Genital papillomatosis in sperm whale bulls. Journal of Wildlife Diseases 23(3):361-367.

Lammers, M. O., A. A. Pack, E. G. Lyman, and L. Espiritu. 2013. Trends in collisions between vessels and North Pacific humpback whales (*Megaptera novaeangliae*) in Hawaiian waters (1975–2011). Journal of Cetacean Research and Management 13(1):73-80.

Lang, A. R., D. W. Weller, R. G. Leduc, A. M. Burdin, and J. Robert L. Brownell. 2010. Genetic differentiation between western and eastern (Eschrichtius robustus) gray whale populations using microsatellite markers. Unpublished paper to the IWC Scientific Committee, Agadir, Morocco.

Laplanche, C., O. Adam, M. Lopatka, and J. F. Motsch. 2005. Sperm whales click focussing: Towards an understanding of single sperm whale foraging strategies. Pages 56 *in* Nineteenth Annual Conference of the European Cetacean Society, La Rochelle, France.

Law, R. J., R. L. Stringer, C. R. Allchin, and B. R. Jones. 1996. Metals and organochlorines in sperm whales (Physeter macrocephalus) stranded around the North Sea during the 1994/1995 winter. Marine Pollution Bulletin 32(1):72-77.

Le Boeuf, B. J., and D. E. Crocker. 2005. Ocean climate and seal condition. BMC Biology 3:9.

Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic: A guide to their identification. NOAA Technical Report NMFS CIRCULAR No. 396. 176p.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Leduc, R. G., and coauthors. 2012. Genetic analysis of right whales in the eastern North Pacific confirms severe extirpation risk. Endangered Species Research 18(2):163-167.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985.

Lien, J. 1994. Entrapments of large cetaceans in passive inshore fishing gear in Newfoundland and Labrador (1979-1990). Reports of the International Whaling Commission Special Issue 15:149-157.

Linnæus, C. 1758. Systema Naturæ per Regna Tria Naturæ, Secundum Classes, Ordines, Genera, Species, Cum Characteribus, Differentiis, Synonymis, Locis, volume Tomus I. Salvius.

Lockyer, C. 1972. The age at sexual maturity of the southern fin whale (Balaenoptera physalus) using annual layer counts in the ear plug. J. Cons. Int. Explor. Mer 34(2):276-294.

Lockyer, C. 1981. Estimates of growth and energy budget for the sperm whale, Physeter catodon. FAO Fisheries Series 5:489-504.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pages 159-171 *in* A. E. Dizon, S. J. Chivers, and W. F. Perrin, editors. Molecular genetics of marine mammals, volume Special Publication 3. Society for Marine Mammalogy

Loughlin, T. R. 2002. Steller's sea lion, *Eumetopias jubatus*. Pages 1181-1185 *in* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, California.

Loughlin, T. R., J. T. Sterling, R. L. Merrick, J. L. Sease, and A. E. York. 2003. Diving behavior of immature Steller sea lions (Eumetopias jubatus). Fishery Bulletin 101:566-582.

Lurton, X., and S. DeRuiter. 2011. Sound radiation of seafloor-mapping echosounders in the water column, in relation to the risks posed to marine mammals. International Hydrographic Review November:7-17.

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., and coauthors. 2004. Parallel influence of climate on the behaviour of Pacific killer whales and Atlantic bottlenose dolphins. Ecology Letters 7:1068-1076.

Lyman, E. 2012. 2011-2012 Season Summary on Large Whale Entanglement threat and reports received around the Main Hawaiian Islands. Hawaiian Islands Humpback Whale National Marine Sanctuary.

Lyrholm, T., and U. Gyllensten. 1998. Global matrilineal population structure in sperm whales as indicated by mitochondrial DNA sequences. Proceedings of the Royal Society of London B 265(1406):1679-1684.

Lyrholm, T., O. Leimar, and U. Gyllensten. 1996. Low diversity and biased substitution patterns in the mitochondrial DNA control region of sperm whales: implications for estimates of time since common ancestry. Molecular Biology and Evolution 13(10):1318-1326.

Lyrholm, T., O. Leimar, B. Johanneson, and U. Gyllensten. 1999. Sex-biased dispersal in sperm whales: Contrasting mitochondrial and nuclear genetic structure of global populations. Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences 266(1417):347-354.

Mackintosh, N. A. 1965. Blue and fin whales. Pages 174-182 *in* The Stocks of Whales. Fishing News.

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, K., M. P. Simmonds, and E. Murray. 2006. Abundance of fin (Balaenoptera physalus) and sei whales (B. borealis) amid oil exploration and development off northwest Scotland. Journal of Cetacean Research And Management 8(3):247-254.

Madsen, P. T., and coauthors. 2003. Sound production in neonate sperm whales (L). Journal of the Acoustical Society of America 113(6):2988-2991.

Madsen, P. T., and coauthors. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. Journal of the Acoustical Society of America 120(4):2366-2379.

Magalhaes, S., and coauthors. 2002. Short-term reactions of sperm whales (*Physeter macrocephalus*) to whale-watching vessels in the Azores. Aquatic Mammals 28(3):267-274.

Marcoux, M., H. Whitehead, and L. Rendell. 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.

Marini, L., C. Consiglio, B. Catalano, T. Valentini, and G. Villetti. 1996. Aerial behavior in fin whales (*Balaenoptera physalus*) in the Mediterranean Sea. Marine Mammal Science 12(3):7.

Marsili, L., and S. Focardi. 1996. Organochlorine levels in subcutaneous blubber biopsies of fin whales (Balaenoptera physalus) and striped dolphins (Stenella coeruleoalba) from the Mediterranean Sea. Environmental Pollution 91(1):1-9.

Martin, A. R., and M. R. Clarke. 1986. The diet of sperm whales (*Physeter macrocephalus*) between Iceland and Greenland. Journal of the Marine Biological Association of the United Kingdom 66:779-790.

Masaki, Y. 1976. Biological studies on the North Pacific sei whale. Bulletin of the Far Seas Fisheries Research Laboratory 14:1-104 +1pl.

Masaki, Y. 1977a. The separation of the stock units of sei whales in the North Pacific. Report of the International Whaling Commission (Special Issue 1):71-79.

Masaki, Y. 1977b. The separation of the stock units of sei whales in the North Pacific. Report of the International Whaling Commission Special Issue 1:71-79.

Maser, C., B. R. Mate, J. F. Franklin, and C. T. Dyrness. 1981. Natural history of Oregon coast mammals. U.S. Department of Agriculture, Forest Service, PNW-133, Portland, OR.

Mate, B., A. Bradford, G. Tsidulko, V. Vertyankin, and V. Ilyashenko. 2011. Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the eastern North Pacific. International Whaling Commission-Scientific Committee, Tromso, Norway.

Mate, B. R., B. A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Marine Mammal Science 15(4):1246-1257.

Matkin, C., and D. Matkin. 1981. Marine mammal survey of southwestern Prince William Sound 1979-1980. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Matthews, J. N., and coauthors. 2001. Vocalisation rates of the North Atlantic right whale (Eubalaena glacialis). Journal of Cetacean Research and Management 3(3):271-282.

Mattila, D. K., and T. Rowles. 2010. A review of large whale entanglement. IWC Scientific Committee, Agadir, Morocco.

Maury, M. F. 1852. Whale chart of the world, series F (wind, and current charts), sheet 1 (Washington, D.C. 1852), sheets 2–4 (no date).

Maury, M. F. 1853. A chart showing the favourite resort of the sperm and right whale. Constructed from Maury's whale chart of the world.

Maybaum, H. L. 1990. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters. EOS 71:92.

McCracken, M. 2013. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2007 to 2011, PIFSC Working Paper.

McDonald, M. A., J. Calambokidis, A. M. Teranishi, and J. A. Hildebrand. 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., and C. G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimation. Journal of the Acoustical Society of America 105(5):2643-2651.

Mcdonald, M. A., J. A. Hildebrand, and S. Mesnick. 2009. Worldwide decline in tonal frequencies of blue whale songs. Endangered Species Research 9(1):13-21.

McDonald, M. A., J. A. Hildebrand, and S. C. Webb. 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., J. A. Hildebrand, and S. M. Wiggins. 2006a. 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., and coauthors. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America 118(6):3941-3945.

McDonald, M. A., S. L. Mesnick, and J. A. Hildebrand. 2006b. 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., S. L. Mesnick, and J. A. Hildebrand. 2006c. Biogeographic characterization of blue whale song worldwide: Using song to identify populations. Journal of Cetacean Research and Management 8(1):55-66.

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. 2011. Blue whale response to underwater noise from commercial ships. University of California, San Diego.

McKenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America 131(2):92-103.

McSweeney, D. J., K. C. Chu, W. F. Dolphin, and L. N. Guinee. 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.

Meigs, H., and coauthors. 2013. Cetacean occurrence and activity in the Papahanaumokuakea Marine National Monument. Pages 142 *in* Twentieth Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

Melcon, M. L., and coauthors. 2012. Blue whales respond to anthropogenic noise. PLoS ONE 7(2):e32681.

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.

Mellinger, D. K., K. M. Stafford, and C. G. Fox. 2004a. Seasonal occurrence of sperm whale (*Physeter macrocephalus*) sounds in the Gulf of Alaska, 1999-2001. Marine Mammal Science 20(1):48-62.

Mellinger, D. K., K. M. Stafford, S. E. Moore, U. Munger, and C. G. Fox. 2004b. Detection of North Pacific right whale (Eubalaena japonica) calls in the Gulf of Alaska. Marine Mammal Science 20(4):872-879.

Merrick, R. L., and T. R. Loughlin. 1997. Foraging behavior of adult female and young-of-the year Steller sea lions in Alaskan waters. Canadian Journal of Zoology 75:776-786.

Mesnick, S. L., and coauthors. 2011. Sperm whale population structure in the eastern and central North Pacific inferred by the use of single-nucleotide polymorphisms, microsatellites and mitochondrial DNA. Molecular Ecology Resources 11(Supplement 1):278-298.

Metcalfe, C., B. Koenig, T. Metcalfe, G. Paterson, and R. Sears. 2004. Intra- and inter-species differences in persistent organic contaminants in the blubber of blue whales and humpback whales from the Gulf of St. Lawrence, Canada. Marine Environmental Research 57:245–260.

Miller, P. J. O., M. P. Johnson, and P. L. Tyack. 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.

Miller, P. J. O., and coauthors. 2012. The severity of behavioral changes observed during experimental exposures of killer (*Orcinus orca*), long-finned pilot (*Globicephala melas*), and sperm (*Physeter macrocephalus*) whales to naval sonar. Aquatic Mammals 38(4):362-401.

Mills, S. K., and J. H. Beatty. 1979. The propensity interpretation of fishes. Philosophy of Science 46(2):263-286.

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. Pages 108-169 *in* W. E. Schevill, editor. The whale problem: A status report. Harvard University Press, Cambridge, MA.

Miyashita, T., H. Kato, and T. Kasuya. 1995. Worldwide map of cetacean distribution based on Japanese sighting data. Volume 1. National Research Institute of Far Seas Fisheries, Shizuoka, Japan. 140pp.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984a. The blue whale, *Balaenoptera musculus*. Marine Fisheries Review 46(4):15-19.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984b. The sei whale, *Balaenoptera borealis*. Marine Fisheries Review 46(4):25-29.

Mizroch, S. A., D. W. Rice, D. Zwiefelhofer, J. Waite, and W. L. Perryman. 1999. Distribution and movements of fin whales (*Balaenoptera physalus*) in the Pacific Ocean. Pages 127 *in* Thirteenth Biennial Conference on the Biology of Marine Mammals, Wailea, Maui, Hawaii.

MMC. 2007. Marine mammals and noise: A sound approach to research and management. Marine Mammal Commission.

Mobley Jr ., J. R., S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys. Southwest Fisheries Science Center, National Marine Fisheries Service.

Mohl, B., M. Wahlberg, P. T. Madsen, A. Heerfordt, and A. Lund. 2003. The monopulsed nature of sperm whale clicks. Journal of the Acoustical Society of America 114(2):1143-1154.

Moore, S. E., K. M. Stafford, D. K. Mellinger, and J. A. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. Bioscience 56(1):49-55.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Mysticete whale abundance and observations of prey associations on the central Bering Sea shelf. Journal of Cetacean Research And Management 2(3):227-234.

Morano, J. L., and coauthors. 2012. Acoustically detected year-round presence of right whales in an urbanized migration corridor. Conservation Biology 26(4):698-707.

Munger, L. M., S. M. Wiggins, S. E. Moore, and J. A. Hildebrand. 2008. North Pacific right whale (Eubalaena japonica) seasonal and diel calling patterns from long-term acoustic recordings in the southeastern Bering Sea, 2000–2006. Marine Mammal Science 24(4):795-814.

Mussoline, S. E., and coauthors. 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):17-26.

Napp, J. M., and G.L. Hunt, Jr. 2001. Anomalous conditions in the southeastern Bering Sea, 1997: linkages among climate, weather, ocean, and biology. Fisheries and Oceanography 10:61-68.

Nasu, K. 1974. Movement of baleen whales in relation to hydrographic conditions in the northern part of the North Pacific Ocean and the Bering Sea. Pages 345-361 *in* Oceanography of the Bering Sea, with Emphasis on Renewable Resources. Institute of Marine Science, University of Alaska, Fairbanks.

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)

Navy. 2012. Marine Species Monitoring for the U.S. Navy's Southern California Range Complex- Annual Report 2012. U.S. Pacific Fleet, Environmental Readiness Division, U.S. Department of the Navy, Pearl Harbor, HI.

Navy. 2013. Hawaii-Southern California Training and Testing Activities Final Environmental Impact Statement/Overseas Environmental Impact Statement.

Neilson, J., C. Gabriele, J. Straley, S. Hills, and J. Robbins. 2005. Humpback whale entanglement rates in southeast Alaska. Pages 203-204 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. Journal of Marine Biology:106282.

Nelson, M., M. Garron, R. L. Merrick, R. M. Pace III, and T. V. N. Cole. 2007a. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2001-2005. U.S. Department of Commerce. Northeast Fisheries Science Center Reference Document 07-05.

Nelson, W. G., R. Brock, H. Lee II, J. O. Lamberson, and F. Cole. 2007b. Condition of bays and estuaries of Hawaii for 2002: A statistical summary. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Washington, D. C. .

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Scientific Reports of the Whales Research Institute Tokyo 12:33-89.

Nemoto, T. 1964. School of baleen whales in the feeding areas. Scientific Reports of the Whales Research Institute Tokyo 18:89-110.

Nemoto, T. 1970. Feeding pattern of baleen whales in the oceans. *In:* Steele, J.H. (ed.), Marine Food Chains. University of California Press, Berkeley, California. p.241-252

Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Report of the International Whaling Commission Special Issue 1:80-87.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. Pages 171-191 *in* K. S. Norris, editor. Whales, dolphins, and porpoises. University of California Press, Berkeley, California.

Nishiwaki, S., and coauthors. 2006. Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPAII) in 2005/2006 - Feasibility study. Paper SC/58/O7 presented to the IWC Scientific Committee, June 2006, St Kitts and Nevis, WI. 21pp.

NMFS. 1991a. Final recovery plan for the humpback whale (*Megaptera novaeangliae*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 1991b. Recovery Plan for the Northern Right Whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 1992. Final recovery plan for Steller sea lions Eumetopias jubatus. NMFS Office of Protected Resources, Silver Spring, Maryland.

NMFS. 1998. Recovery plan for the blue whale (*Balaenoptera musculus*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 2005. Biological Opinion on the Issuance of Scientific Research Permits (batched) in the North Pacific Ocean for Research on Large Whales and Pinnipeds (Permit Nos. 545-1761, 587-1767, 1071-1770, 731-1774, 393-1772, 945-1776, 1000-1617, 774-1719-02, 774-1714). NMFS Office of Protected Resources, Silver Spring, Maryland. 61p.

NMFS. 2006a. Biological Opinion on Sinking Exercises (SINKEX) in the Western North Atlantic Ocean. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. 119p.

NMFS. 2006b. 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. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2006c. Draft recovery plan for the fin whale (Balaenoptera physalus). National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 2006d. Draft recovery plan for the sperm whale (*Physeter macrocephalus*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 2006e. Draft Recovery Plan for the Sperm Whale (*Physeter Macrocephalus*). National Marine Fisheries Service, Silver Spring, Maryland. 92p.

NMFS. 2006f. Review of the status of the right whales in the North Atlantic and North Pacific Oceans. NOAA, National Marine Fisheries Service.

NMFS. 2008. Final programmatic biological opinion on U.S. Navy activities in the Hawaii Range Complex 2008-2013.

NMFS. 2009. Sperm whale (*Physeter macrocephalus*): 5-year review: Summary and evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 2011. Hawaii pelagic longline fishery regulation summary. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Regional Office.

NMFS. 2013. U.S. National Bycatch Report First Edition Update 1. U.S. Dep. Commer.

NOAA. 2004. NOAA scientists sight blue whales in Alaska: critically endangered blue whales rarely seen in Alaska waters. NOAA.

NOAA. 2014. 2014 report on the entanglement of marine species in marine debris with an emphasis on species in the United States. National Oceanic and Atmospheric Administration, Marine Debris Program, Silver Spring, Maryland.

Noren, D. P., and J. A. Mocklin. 2011. Review of cetacean biopsy techniques: Factors contributing to successful sample collection and physiological and behavioral impacts. Marine Mammal Science in press.

Norman, S. A., and coauthors. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management 6(1):87-99.

Norris, K. S., and G. W. Harvey. 1972. A theory for the function of the spermaceti organ of the sperm whale (*Physeter catodon* L.). Pages 397-417 *in* S. R. Galler, K. Schmidt-Koenig, G. J. Jacobs, and R. E. Belleville, editors. Animal Orientation and Navigation. National Air and Space Administration, Washington, D. C.

Norris, T. F. 1994. Effects of boat noise on the acoustic behavior of humpback whales. Journal of the Acoustical Society of America 95(5 Part 2):3251.

Northrop, J. W., C. Cummings, and M. F. Morrison. 1971. Underwater 20-Hz signals recorded near Midway Island. Journal of the Acoustical Society of America 49:1909-1910.

Northrop, J. W., C. Cummings, and P. O. Thompson. 1968. 20-Hz signals observed in the central Pacific. Journal of the Acoustical Society of America 43:383-384.

Notarbartolo-Di-Sciara, G., C. W. Clark, M. Zanardelli, and S. Panigada. 1999. Migration patterns of fin whales, *Balaenoptera physalus*: Shaky old paradigms and local anomalies. Pages 118 *in* P. G. H. Evan, and E. C. M. Parsons, editors. Twelfth Annual Conference of the European Cetacean Society, Monaco.

Nowacek, D., P. Tyack, and M. Johnson. 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., M. P. Johnson, and P. L. Tyack. 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.

NRC. 2003a. Decline of the Steller sea lion in Alaskan waters. (National Research Council). National Academies Press, Washington, D.C.

NRC. 2003b. Ocean Noise and Marine Mammals. National Academies Press.

NRC. 2005. Marine mammal populations and ocean noise. Determining when noise causes biologically significant effects. National Academy of Sciences, Washington, D. C.

Ohsumi, S., and Y. Fukuda. 1975. Report of the Scientific Committee, Annex I. A review on population estimates for the North Pacific sei whales. (Balaenoptera borealis). Report of the International Whaling Commission 25:95-101.-Sc/26/5).

Ohsumi, S., and S. Wada. 1972. Stock assessment of blue whales in the North Pacific. Working Paper for the 24th Meeting of the International Whaling Commission. 20 pp.

Oleson, E. M., J. Calambokidis, J. Barlow, and J. A. Hildebrand. 2007a. Blue whale visual and acoustic encounter rates in the southern California bight. Marine Mammal Science 23(3):574-597.

Oleson, E. M., S. M. Wiggins, and J. A. Hildebrand. 2007b. Temporal separation of blue whale call types on a southern California feeding ground. Animal Behaviour 74(4):881-894.

Omura, H. 1958. North Pacific right whale.

Omura, H., T. Ichihara, and T. Kasuya. 1970. Osteology of pygmy blue whale with additional information on external and other characteristics. (Balaenoptera musculus brevicauda). Scientific Reports of the Whales Research Institute Tokyo 22:1-27, +5Pls.

Omura, H., S. Ohsumi, K. N. Nemoto, and T. Kasuya. 1969. Black right whales in the north Pacific. Scientific Reports of the Whales Research Institute 21.

ONR. 2001. Final Environmental Impact Statement for the North Pacific Acoustic Laboratory.Prepared by the Office of Naval Research, Arlington, Virginia.

Pack, A. A., and coauthors. 2012. Size-assortative pairing and discrimination of potential mates by humpback whales in the Hawaiian breeding grounds. Animal Behaviour 84(4):983-993.

Pack, A. A., and coauthors. 2009. Male humpback whales in the Hawaiian breeding grounds preferentially associate with larger females. Animal Behaviour 77(3):653-662.

Palacios, D. M., and B. R. Mate. 1996. Attack by false killer whales (*Pseudorca crassidens*) on sperm whales (*Physeter macrocephalus*) in the Galápagos Islands. Marine Mammal Science 12(4):582-587.

Paloma, L. D. G., B. E. Lavaniegos, and G. Heckel. 2008. Fin whales (Balaenoptera physalus) foraging on daytime surface swarms of the euphausiid Nyctiphanes simplex in Ballenas Channel, Gulf of California, Mexico. Journal of Mammalogy 89(32):559-566.

Panigada, S., and coauthors. 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin 52:1287-1298.

Panigada, S., M. Zanardelli, S. Canese, and M. Jahoda. 1999. How deep can baleen whales dive? Marine Ecology Progress Series 187:309-311.

Panigada, S., and coauthors. 2008. Modelling habitat preferences for fin whales and striped dolphins in the Pelagos Sanctuary (Western Mediterranean Sea) with physiographic and remote sensing variables. Remote Sensing of Environment 112(8):3400-3412.

Papastavrou, V., S. C. Smith, and H. Whitehead. 1989. Diving behaviour of the sperm whale, *Physeter macrocephalus*, off the Galápagos Islands. Canadian Journal of Zoology 67:839-846.

Parks, S. E. 2003. Acoustic communication in the North Atlantic right whale (*Eubalaena glacialis*). Massachusetts Institute of Technology and Woods Hole Oceanographic Institution.

Parks, S. E. 2009. Assessment of acoustic adaptations for noise compensation in marine mammals. 2009 ONR Marine Mammal Program Review, Alexandria, Virginia.

Parks, S. E., and C. W. Clark. 2007. Acoustic communication: Social sounds and the potential impacts of noise. Pages 310-332 *in* S. D. Kraus, and R. Rolland, editors. The Urban Whale: North Atlantic Right Whales at the Crossroads. Harvard University Press, Cambridge, Massahusetts.

Parks, S. E., C. W. Clark, and P. L. Tyack. 2005a. North Atlantic right whales shift their frequency of calling in response to vessel noise. Pages 218 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Parks, S. E., C. W. Clark, and P. L. Tyack. 2007a. 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., P. K. Hamilton, S. D. Kraus, and P. L. Tyack. 2005b. 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., C. F. Hotchkin, K. A. Cortopassi, and C. W. Clark. 2012a. 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., M. Johnson, D. Nowacek, and P. L. Tyack. 2011. Individual right whales call louder in increased environmental noise. Biology Letters 7(1):33-35.

Parks, S. E., M. Johnson, and P. Tyack. 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., M. P. Johnson, D. P. Nowacek, and P. L. Tyack. 2012b. Changes in vocal behavior of North Atlantic right whales in increased noise. Pages 4 *in* A. N. Popper, and A. Hawkings, editors. The Effects of Noise on Aquatic Life. Springer Science.

Parks, S. E., D. R. Ketten, J. T. O'Malley, and J. Arruda. 2007b. 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., K. M. Kristrup, S. D. Kraus, and P. L. Tyack. 2003. Sound production by North Atlantic right whales in surface active groups. Pages 127 *in* Fifteenth Biennial Conference on the Biology of Marine Mammals, Greensboro, North Carolina.

Parks, S. E., S. E. Parks, C. W. Clark, and P. L. Tyack. 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., I. Urazghildiiev, and C. W. Clark. 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.

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., and coauthors. 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., P. Tyack, and R. Payne. 1983. Progressive changes in the songs of humpback whales (*Megaptera novaeangliae*): A detailed analysis of two seasons in Hawaii. Pages 9-57 *in* R. Payne, editor. Communication and Behavior of Whales. Westview Press, Boulder, CO.

Payne, P., J. Nicholas, L. O'Brien, and K. Powers. 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., and coauthors. 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.

Perkins, J., and D. Beamish. 1979. Net entanglements of baleen whales in the inshore fishery of Newfoundland. Journal of the Fisheries Research Board of Canada 36:521-528.

Perry, S. L., D. P. DeMaster, and G. K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61(1):1-74.

Perryman, W. L., R. LeDuc, and J. R. L. Brownell. 1999. Progress report on eastern North Pacific right whale research during July 1998. International Whaling Committee Scientific Committee paper SC/51/CAWS36.

Petras, E. 2003. A review of marine mammal deterrents and their possible applications to limit killer whale (*Orcinus orca*) predation on Steller sea lions (*Eumetopias jubatus*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Pettis, J., F. Ollervides, and J. Packard. 1999. Gray whale *Eschrichtius robustus* behavior as an indicator of boat harassment. Pages 147 *in* Thirteenth Biennial Conference on the Biology of Marine Mammals, Wailea, Maui, Hawaii.

Picanco, C., I. Carvalho, and C. Brito. 2009. Occurrence and distribution of cetaceans in Sao Tome and Príncipe tropical archipelago and their relation to environmental variables. Journal of the Marine Biological Association of the United Kingdom 89(5):1071-1076.

Pike, G. C., and I. B. Macaskie. 1969. Marine mammals of British Columbia. Bulletin of the Fisheries Research Board of Canada 171:1-54.

Pinela, A. M., and coauthors. 2009. Population genetics and social organization of the sperm whale (Physeter macrocephalus) in the Azores inferred by microsatellite analyses. Canadian Journal of Zoology 87(9):802-813.

Pinto De Sa Alves, L. C., A. Andriolo, A. N. Zerbini, J. L. A. Pizzorno, and P. J. Clapham. 2009. Record of feeding by humpback whales (Megaptera novaeangliae) in tropical waters off Brazil. Marine Mammal Science 25(2):416-419.

Pitcher, K. W., and coauthors. 2005. Ontogeny of dive performance in pup and juvenile Steller sea lions in Alaska. Canadian Journal of Zoology 83:1214-1231.

Pitman, R. L., L. T. Ballance, S. I. Mesnick, and S. J. Chivers. 2001. Killer whale predation on sperm whales: observations and implications. Marine Mammal Science 17(3):494-507.

Program, N. O. a. A. A. M. D. 2014. Report on the Entanglement of Marine Species in Marine Debris with an Emphasis on Species in the United States, Silver Spring, MD.

Punt, A. E. 2010. Further analyses related to the estimation of the rate of increase for an unknown stock using a Bayesian meta-analysis. IWC Scientific Committee, Agadir, Morocco.

Ramp, C., J. Delarue, M. Berube, P. S. Hammond, and R. Sears. 2014. Fin whale survival and abundance in the Gulf of St. Lawrence, Canada. Endangered Species Research 23(2):125-132.

Ramp, C., W. Hagen, P. Palsboll, M. Berube, and R. Sears. 2010. Age-related multi-year associations in female humpback whales (Megaptera novaeangliae). Behavioral Ecology and Sociobiology 64(10):1563-1576.

Rankin, C. H., and coauthors. 2009. Habituation revisited: An updated and revised description of the behavioral characteristics of habituation. Neurobiology of Learning and Memory 92(2):135-138.

Rankin, S., and J. Barlow. 2007. Vocalizations of the sei whale *Balaenoptera borealis* off the Hawaiian Islands. Bioacoustics 16(2):137-145.

Rankin, S., D. Ljungblad, C. Clark, and H. Kato. 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.

Ray, G. C., E. D. Mitchell, D. Wartzok, V. M. Kozicki, and R. Maiefski. 1978. Radio tracking of a fin whale (*Balaenoptera physalus*). Science 202(4367):521-524.

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.

Reeves, R. R. 1977. The problem of gray whale (*Eschrichtius robustus*) harassment: At the breeding lagoon and during migration. Marine Mammal Commission.

Reeves, R. R., P. J. Clapham, R. L. B. Jr., and G. K. Silber. 1998. Recovery plan for the blue whale (Balaenoptera musculus). Office of Protected Resources, Silver Spring, MD.

Reeves, R. R., S. Leatherwood, S. A. Karl, and E. R. Yohe. 1985. Whaling results at Akutan (1912-39) and Port Hobron (1926-37). Report of the International Whaling Commission 35:441-457.

Reeves, R. R., B. D. Smith, E. A. Crespo, and G. Notarbartolo di Sciara. 2003. Dolphins, whales and porpoises: 2002–2010 conservation action plan for the world's cetaceans.

Reeves, R. R., T. D. Smith, and E. A. Josephson. 2008. Observations of western gray whales by ship-based whalers in the 19th century. IWC Scientific Committee, Santiago, Chile.

Reeves, R. R., T. D. Smith, E. A. Josephson, P. J. Clapham, and G. Woolmer. 2004. Historical observations of humpback and blue whales in the North Atlantic Ocean: Clues to migratory routes and possibly additional feeding grounds. Marine Mammal Science 20(4):774-786.

Reeves, R. R., B. S. Stewart, P. Clapham, and J. Powell. 2002. Guide to marine mammals of the world. Knopf, New York.

Reeves, R. R., and H. Whitehead. 1997. Status of sperm whale, *Physeter macrocephalus*, in Canada. Canadian Field-Naturalist 111:293-307.

Rehberg, M. J., K. L. Raum-Suryan, K. W. Pitcher, and T. S. Gelatt. 2001. Development of juvenile Steller sea lion (Eumetopias jubatus) diving behaviour in Alaska. Pages 177 *in* Fourteenth Biennial Conference on the Biology of Marine Mammals., Vancouver, Canada.

Reilly, S. B., and V. G. Thayer. 1990. Blue whale (*Balaenoptera musculus*) distribution in the Eastern Tropical Pacific. Marine Mammal Science 6(4):265-277.

Rendell, L., S. L. Mesnick, M. L. Dalebout, J. Burtenshaw, and H. Whitehead. 2011. Can genetic differences explain vocal dialect variation in sperm whales, Physeter macrocephalus? Behavior Genetics.

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.

Reynolds, J. E., D. P. DeMaster, and G. K. Silber. 2002. Endangered species and populations. Pages 373-382 in: Perrin, W.F., B. Würsig, and J.G.M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press. San Diego, California.

Rice, D. W. 1960. Distribution of the bottle-nosed dolphin in the leeward Hawaiian Islands. Journal of Mammalogy 41:407-408.

Rice, D. W. 1974a. Whales and whale research in the eastern North Pacific.Pp.170-195 *In:* The whale problem: a status report. W.E. Schevill (ed). Harvard Univ. Press, Cambridge, Mass. 419p.

Rice, D. W. 1974b. Whales and whale research in the eastern North Pacific. Pages 170-195 *in* W. E. Schevill, editor. The Whale Problem. Harvard University Press, Cambridge, Massahusetts.

Rice, D. W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Report of the International Whaling Commission (Special Issue 1):92-97.

Rice, D. W. 1978a. The humpback whale in the North Pacific: distribution, exploitation, and numbers. . U.S. Marine Mammal Commission, NTIS PB-280-794.

Rice, D. W. 1978b. Sperm whales.p.82-87 *In*: D. Haley (ed), Marine Mammals of the Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle, Washington. 256p.

Rice, D. W. 1989a. Sperm whale, *Physeter macrocephalus* (Linnaeus, 1758). Pages 177-233 *in* S. H. Ridway, and S. R. Harrison, editors. Handbook of Marine Mammals Volume 4: River Dolphins and the Larger Toothed Whales, volume 4.

Rice, D. W. 1989b. Sperm whale, *Physeter macrocephalus* (Linnaeus, 1758). Pages 177-233 *in* S. H. Ridway, and S. R. Harrison, editors. Handbook of Marine Mammals. Volume 4: River Dolphins and the Larger Toothed Whales. Academic Press Inc, London.

Rice, D. W. 1998a. Marine Mammals of the World. Systematics and Distribution.Special Publication Number 4. The Society for Marine Mammalogy, Lawrence, Kansas.

Rice, D. W. 1998b. Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Lawrence, KS.

Rice, D. W., A. A. Wolman, B. R. Mate, and J. T. Harvey. 1986. A Mass Stranding of Sperm Whales in Oregon - Sex and Age Composition of the School. Marine Mammal Science 2(1):64-69.

Rice, D. W., and A. A. Wolman. 1982. Whale census in the Gulf of Alaska, June to August 1980. Report of the International Whaling Commission 32:491-497.-Sc/33/O7).

Richardson, W. J., C. R. G. Jr., C. I. Malme, and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, Inc., San Diego, California.

Richardson, W. J., and B. Wursig. 1995. Significance of responses and noise impacts. Pages 387-424 *in* W. J. Richardson, C. R. Greene Jr., C. I. Malme, and D. H. Thomson, editors. Marine Mammals and Noise. Academic Press, San Diego.

Richter, C., S. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22(1):46-63.

Richter, C. F., S. M. Dawson, and E. Slooten. 2003. Sperm whale watching off Kaikoura, New Zealand: effects of current activities on surfacing and vocalisation patterns. Science for Conservation [Sci. Conserv.]. no. 219.

Ridgway, S. H., and D. A. Carder. 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. Aquatic Mammals 27(3):267-276.

Rivers, J. A. 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. Marine Mammal Science 13(2):186-195.

Rone, B. K., and coauthors. 2010. Results of the April 2009 Gulf of Alaska Line-Transect Survey (GOALS) in the Navy Training Exercise Area. NOAA.

Ross, D. 1976. Mechanics of Unterwater Noise. Pergamon Press, New York.

Ruud, J. T. 1956. The blue whale. (Balaenoptera musculus). Scientific American 195:46-50.

Ryan, C., and coauthors. 2014. Levels of persistent organic pollutants in eastern North Atlantic humpback whales. Endangered Species Research 22(3):213-223.

Salden, D. R. 1993. Effects of research boat approaches on humpback whale behavior off Maui, Hawaii, 1989-1993. Pages 94 *in* Tenth Biennial Conference on the Biology of Marine Mammals, Galveston, Texas.

Samaran, F., C. Guinet, O. Adam, J. F. Motsch, and Y. Cansi. 2010. Source level estimation of two blue whale subspecies in southwestern Indian Ocean. Journal of the Acoustical Society of America 127(6):3800-3808.

Saracco, J. F., C. M. Gabriele, and J. L. Neilson. 2013. Population dynamics and demography of humpback whales in Glacier Bay and Icy Strait, Alaska. Northwestern Naturalist 94(3):187-197.

Saski, H., and coauthors. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. Fisheries Oceanography 22(6):496-508.

Scarff, J. E. 1986. Historic and present distribution of the right whale (*Eubalaena glacialis*) in the eastern North Pacific south of 50°N and east of 180°W. Report of the International Whaling Commission (Special Issue 10):43-63.

Scarff, J. E. 1991. Historic distribution and abundance of the right whale (Eubalaena glacialis) in the North Pacific, Bering Sea, Sea of Okhotsk, and Sea of Japan from the Maury Whale Charts. Reports of the International Whaling Commission 41:467-489.

Schakner, Z. A., and D. T. Blumstein. 2013. Behavioral biology of marine mammal deterrents: A review and prospectus. Biological Conservation 167:380-389.

Scheidat, M., C. Castro, J. Gonzalez, and R. Williams. 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.

Schevill, W. E., W. A. Watkins, and R. H. Backus. 1964. The 20-cycle signals and *Balaenoptera* (fin whales). Pages 147-152 *in* W. N. Tavolga, editor Marine Bio-acoustics. Pergamon Press, Lerner Marine Laboratory, Bimini, Bahamas.

Schoenherr, J. R. 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. (*Balaenoptera musculus*). Canadian Journal of Zoology 69(3):583-594.

Schuyler, Q., B. D. Hardesty, C. Wilcox, and K. Townsend. 2013. Global analysis of anthropogenic debris ingestion by sea turtles. Conservation Biology.

Scott, T. M., and S. Sadove. 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. Marine Mammal Science 13(2):4.

Sears, R., C. Ramp, A. B. Douglas, and J. Calambokidis. 2014. Reproductive parameters of eastern North Pacific blue whales *Balaenoptera musculus*. Endangered Species Research 22(1):23-31.

Sears, R., and coauthors. 1990. Photographic identification of the blue whale (Balaenoptera musculus) in the Gulf of St. Lawrence, Canada. Reports of the International Whaling Commission Special Issue 12:335-342.

Sergeant, D. E. 1977. Stocks of fin whales *Balaenoptera physalus* L. in the North Atlantic Ocean. Report of the International Whaling Commission 27:460-473.

Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23.

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.

Shelden, K. E. W., and P. J. Clapham. 2006. Habitat requirements and Extinction Risks of Eastern North Pacific Right Whales. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Shelden, K. E. W., S. E. Moore, J. M. Waite, P. R. Wade, and D. J. Rugh. 2005. Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. Mammal Review 35(2):129-155.

Shirihai, H. 2002. A complete guide to Antarctic wildlife. Alula Press, Degerby, Finland.

Sigurjonsson, J., T. Gunnlaugsson, and M. Payne. 1989. NASS-87: Shipboard sightings surveys in Icelandic and adjacent waters June-July 1987. Report of the International Whaling Commission 39:395-409.

Silber, G., J. Slutsky, and S. Bettridge. 2010. Hydrodynamics of a ship/whale collision. Journal of Experimental Marine Biology and Ecology 391:10-19.

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. Unpublished paper submitted to the Scientific Committee of the International Whaling Commission SC/57/WW5, Cambridge, United Kingdom.

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.

Simon, M., K. M. Stafford, K. Beedholm, C. M. Lee, and P. Madsen. 2010. Singing behavior of fin whales in the Davis Strait with implications for mating, migration and foraging. Journal of the Acoustical Society of America 128(5):3200-3210.

Sirovic, A., J. A. Hildebrand, and S. M. Wiggins. 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., L. N. Williams, S. M. Kerosky, S. M. Wiggins, and J. A. Hildebrand. 2012. Temporal separation of two fin whale call types across the eastern North Pacific. Marine Biology 160(1):47-57.

Sivle, L. D., and coauthors. 2012. Changes in dive behavior during naval sonar exposure in killer whales, long-finned pilot whales, and sperm whales. Frontiers in Physiology 3:400.

Slijper, E. J. 1962. Whales. English translation Hutchinson & Co. (Publishers). First published in the U.S. by Basic Books Publishing Co., Inc, New York. 475pp.

Slikas, B., and coauthors. 2013. The right whale for next-generation sequencing - worldwide phylogenetic relationships and oceanic diversity. Pages 193-194 *in* Twentieth Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

Smith, A. W., and A. B. Latham. 1978. Prevalence of vesicular exanthema of swine antibodies among feral animals associated with the southern California coastal zones. American Journal of Veterinary Research 39:291–296.

Smith, J. N., A. W. Goldizen, R. A. Dunlop, and M. J. Noad. 2008. Songs of male humpback whales, Megaptera novaeangliae, are involved in intersexual interactions. Animal Behaviour 76(2):467-477.

Smith, T. D., and D. G.Pike. 2009. The enigmatic whale: the North Atlantic humpback. NAMMCO Scientific Publications 7:161-178.

Smultea, M. A., J. L. Hayes, and A. M. Zoidis. 2007. Marine Mammal and Sea Turtle Monitoring Survey in Support of Navy Training Exercises in the Hawai'i Range Complex, Pearl Harbor, Hawaii.

Smultea, M. A., T. A. Jefferson, and A. M. Zoidis. 2010. Rare sightings of a bryde’s whale (*Balaenoptera edeni*) and sei whales (*B. borealis*) (Cetacea: Balaenopteridae) northeast of O‘ahu, Hawai‘i. Pacific Science 64(3):449-457.

Southall, B., and coauthors. 2011a. Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2010 (“SOCAL -10”).

Southall, B. L., and coauthors. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33(4):411-521.

Southall, B. L., and coauthors. 2006. Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

Southall, B. L., and coauthors. 2011b. Biological and behavioral response studies of marine mammals in southern California (SOCAL-10). Pages 279 *in* Nineteenth Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

Southall, B. L., T. Rowles, F. Gulland, R. W. Baird, and P. D. Jepson. 2013. Final report of the independent scientific review panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar.

Stafford, K. M. 2003. Two types of blue whale calls recorded in the Gulf of Alaska. Marine Mammal Science 19(4):12.

Stafford, K. M., C. G. Fox, and D. S. Clark. 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., D. K. Mellinger, S. E. Moore, and C. G. Fox. 2007. Seasonal variability and detection range modeling of baleen whale calls in the Gulf of Alaska, 1999–2002. The Journal of the Acoustical Society of America 122(6):3378-3390.

Stafford, K. M., and S. E. Moore. 2005a. Atypical calling by a blue whale in the Gulf of Alaska (L). Journal of the Acoustical Society of America 117(5):2724-2727.

Stafford, K. M., and S. E. Moore. 2005b. Atypical calling by a blue whale in the Gulf of Alaska (L). Journal of the Acoustical Society of America 117(5):2724-2727.

Stafford, K. M., S. L. Nieukirk, and C. G. Fox. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. Journal of Cetacean Research and Management 3(1):65-76.

Stearns, S. C. 1992. The Evolution of Life Histories. Oxford Press, Oxford.

Steiger, G. H., and coauthors. 2008. Geographic variation in killer whale attacks on humpback whales in the North Pacific: Implications for predation pressure. Endangered Species Research 4:247-256.

Stewart, B. S., S. A. Karl, P. K. Yochem, S. Leatherwood, and J. L. Laake. 1987. Aerial surveys for cetaceans in the former Akutan, Alaska, whaling grounds. Arctic 40(1):33-42.

Stimpert, A. K., D. N. Wiley, W. W. L. Au, M. P. Johnson, and R. Arsenault. 2007. ‘Megapclicks’: Acoustic click trains and buzzes produced during night-time foraging of humpback whales (Megaptera novaeangliae). Biology Letters 3(5):467-470.

Stone, G. S., S. K. Katona, A. Mainwaring, J. M. Allen, and H. D. Corbett. 1992. Respiration and surfacing rates of fin whales (Balaenoptera physalus) observed from a lighthouse tower. Reports of the International Whaling Commission 42:739-745.

Straley, J., and T. O'Connell. 2005. Sperm whale interactions with longline fisheries in the Gulf of Alaska. Oncorhynchus 15(1):1-2.

Straley, J., T. O'Connell, L. Behnken, and A. Thode. 2005. Southeast Alaska Sperm Whale Avoidance Project: Fishermen and Scientists Working to Reduce Whale Depredation on Longlines.

Strong, C. S. 1990. Ventilation patterns and behavior of balaenopterid whales in the Gulf of California, Mexico. Unpublished master's thesis, San Francisco State University, California.

Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. McLellan, and D. A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Marine Mammal Science 9(3):309-315.

Tamura, T., and coauthors. 2009. Some examinations of uncertainties in the prey consumption estimates of common minke, sei and Bryde's whales in the western North Pacific. Unpublished paper to the IWC Scientific Committee, Madeira, Portugal.

Tarpy, C. 1979. Killer Whale Attack! National Geographic 155(4):542-545.

Teloni, V., W. M. X. Zimmer, M. Wahlberg, and P. T. Madsen. 2007. Consistent acoustic size estimation of sperm whales using clicks recorded from unknown aspects. Journal of Cetacean Research And Management 9(2):127-136.

Thode, A., J. Straley, C. O. Tiemann, K. Folkert, and V. O'Connell. 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.

Thompson, P. O., W. C. Cummings, and S. J. Ha. 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., L. T. Findley, O. Vidal, and W. C. Cummings. 1996. Underwater sounds of blue whales, *Balaenoptera musculus*, in the Gulf of California, Mexico. Marine Mammal Science 12(2):288-293.

Thompson, P. O., L. T. Findley, and O. Vidal. 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, P. O., and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

Thompson, T. J., H. E. Winn, and P. J. Perkins. 1979. Mysticete sounds. Pages 403-431 *in* H. E. Winn, and B. L. Olla, editors. Behavior of Marine Animals: Current Perspectives in Research, volume 3 Cetaceans. Plenum Press, New York.

Thomson, D. H., and W. J. Richardson. 1995. Marine mammal sounds. W. J. Richardson, J. C. R. Greene, C. I. Malme, and D. H. Thomson, editors. Marine Mammals and Noise. Academic Press, San Diego, California.

Tillman, M. F. 1977. Estimates of population size for the North Pacific sei whale. Report of the International Whaling Commission (Special Issue 1):98-106.

Tomilin, A. G. 1967. Mammals of the USSR and adjacent countries, Vol. 9, Cetacea. Akademiya Nauk SSR, Moscow. (Translated from Russian by Israel Program for Scientific Translantions. 717 pgs.).

Tonnessen, J. N., and A. O. Johnsen. 1982. The History of Modern Whaling. University of California Press, Berkeley, California.

Townsend, C. H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19:1–50.

Trumble, S. J., E. M. Robinson, M. Berman-Kowalewski, C. W. Potter, and S. Usenko. 2013. Blue whale earplug reveals lifetime contaminant exposure and hormone profiles. Proceedings of the National Academy of Sciences 110(42):16922-16926.

Turner, R. F., and coauthors. 1987. Geological and operational summary, Kodiak Shelf stratigraphic test wells, Western Gulf of Alaska. United States Department of the Interior, Minerals Management Service, Alaska OCS Region.

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. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behavioral Ecology and Sociobiology 8:105-116.

Tyack, P. L. 1999. Communication and cognition. Pages 287-323 *in* J. E. R. III, and S. A. Rommel, editors. Biology of Marine Mammals. Smithsonian Institution Press, Washington.

Tynan, C. T., and coauthors. 2005. Cetacean distributions relative to ocean processes in the northern California Current System. Deep Sea Research Part II: Topical Studies in Oceanography 52(1-2):145-167.

Tynan, C. T., D. P. Demaster, and W. T. Peterson. 2001. Endangered right whales on the southeastern Bering Sea shelf. Science 294(5548):1894.

Tyson, R. B., and D. P. Nowacek. 2005. Nonlinear dynamics in North Atlantic right whale (*Eubalaena glacialis*) vocalizations. Pages 286 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Urick, R. J. 1983. Principles of Underwater Sound. McGraw-Hill.

Van Opzeeland, I., S. V. Parijs, L. Kindermann, E. Burkhardt, and O. Boebel. 2013. Calling in the cold: Pervasive acoustic presence of humpback whales (*Megaptera novaeangliae*) in Antarctic coastal waters. PLoS ONE 8(9):e73007.

Van Waerebeek, K., and G. Engblom. 2007. Fin whales off Peru, unseasonal, nondescript and undersized: Further indications for a possible third subspecies of fin whale. International Whaling Commission Scientific Committee, Anchorage, Alaska.

Vanderlaan, A. S. M., A. E. Hay, and C. T. Taggart. 2003. Characterization of North Atlantic right-whale (Eubalaena glacialis) sounds in the Bay of Fundy. IEEE Journal of Oceanic Engineering 28(2):164-173.

Vanderlaan, A. S. M., C. T. Taggart, A. R. Serdynska, R. D. Kenney, and M. W. Brown. 2008. Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf. Endangered Species Research 4(3):283-297.

Viale, D., N. Verneau, and Y. Tison. 1992. Stomach obstruction in a sperm whale beached on the Lavezzi islands: macropollution in the Mediterranean. Journal de Recherche Oceanographique 16:100-102.

Wade, P. M., and coauthors. 2006. Acoustic detection and satellite tracking leads to discovery of rare concentration of endangered North Pacific right whales. Biology Letters 2:417-419.

Wade, P. R., A. M. Burdin, A. L. Bradford, R. L. Brownell, and D. W. Weller. 2003a. Abundance estimates of western gray whales (*Eschrichtius robustus*) off northeastern Sakhalin Island, Russia. International Whaling Commission Scientific Committee, Berlin.

Wade, P. R., J. W. Durban, J. M. Waite, A. N. Zerbini, and M. E. Dahlheim. 2003b. Surveying killer whale abundance and distribution in the Gulf of Alaska and Aleutian Islands. NOAA.

Wade, P. R., and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the Eastern Tropical Pacific. Report of the International Whaling Commission 43(477-493).

Wade, P. R., and coauthors. 2011a. The world's smallest whale population? Biology Letters 7(1):83-85.

Wade, P. R., and coauthors. 2011b. The world's smallest whale population? Biology Letters 7(1):83-85.

Waite, J. 2003. Cetacean Survey. National Marine Mammal Laboratory (NMML), Cetacean Assessment and Ecology Program, Quarterly Report. Available online at: http://www.afsc.noaa.gov/Quarterly/jas2003/divrptsNMML2.htm Accessed 5/30/08.

Waite, J. M., K. Wynne, and D. K. Mellinger. 2003. Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. Northwestern Naturalist 84(1):38-43.

Walker, K. A., A. W. Trites, M. Haulena, and D. M. Weary. 2012. A review of the effects of different marking and tagging techniques on marine mammals. Wildlife Research 39(1):15-30.

Waring, G., D. Belden, M. Vecchione, and R. Gibbons. 2003. Mid-water prey in beaked whale and sperm whale deep-water habitat south of Georges Bank. Pages 172 *in* Fifteenth Biennial Conference on the Biology of Marine Mammals, Greensboro, North Carolina.

Waring, G. T. 1993. Spatial patterns of six cetaceans along a linear habitat. Tenth Biennial Conference on the Biology of Marine Mammals, 11-15 November Galveston TX. p.2. Symposium: Cetacean Habitats.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano. 1993a. Sperm whales associated with Gulf Stream features off the north-eastern USA shelf. Fisheries Oceanography 2(2):101-105.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano. 1993b. Sperm whales associated with Gulf Stream features off the north-eastern USA shelf. Fisheries Oceanography 2(2):101-105.

Waring, G. T., E. Josephson, C. P. Fairfield, and K. Maze-Foley. 2006. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2005. NOAA Technical Memorandum NMFS-NE-194. Woods Hole, Massachusetts. 358p.

Waring, G. T., E. Josephson, C. P. Fairfield, and K. Maze-Foley. 2007. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments -- 2006. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, NOAA Technical Memorandum NMFS-NE-201, Woods Hole, Massachusetts.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2013. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2012. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Waring, G. T., R. M. Pace, J. M. Quintal, C. P. Fairfield, and K. Maze-Foley. 2004. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments -- 2003. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

Watkins, W. A. 1977. Acoustic behavior of sperm whales. Oceanus 20:50-58.

Watkins, W. A. 1981a. Activities and underwater sounds of fin whales. Scientific Reports of the Whales Research Institute 33:83-117.

Watkins, W. A. 1981b. Activities and underwater sounds of fin whales. (Balaenoptera physalus). Scientific Reports of the Whales Research Institute Tokyo 33:83-118.

Watkins, W. A. 1981c. Reaction of three species of whales, *Balaenoptera physalus, Megaptera novaeangliae*, and *Balaenoptera edeni* to implanted radio tags. Deep Sea Research Part I: Oceanographic Research Papers 28(6):589-599.

Watkins, W. A. 1986. Whale reactions to human activities in Cape Cod waters. Marine Mammal Science 2(4):251-262.

Watkins, W. A., M. A. Daher, K. M. Fristrup, T. J. Howald, and G. Notarbartolo-di-Sciara. 1993. Sperm whale tagged with transponders and tracked underwater by sonar. Marine Mammal Science 9(1):55-67.

Watkins, W. A., and coauthors. 2000. Whale call data for the North Pacific November 1995 through July 1999: Occurrence of calling whales and source locations from SOSUS and other acoustic systems.Technical Report WHOI_00_02 available from Woods Hole Oceanographic Institution. 160pp.

Watkins, W. A., and C. A. Goebel. 1984. Sonar observations explain behaviors noted during boat maneuvers for radio tagging of humpback whales (*Megaptera novaeangliae*) in the Glacier Bay area [Alaska, USA]. Cetology 48:1-8.

Watkins, W. A., K. E. Moore, and P. L. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology 49:1-15.

Watkins, W. A., K. E. Moore, D. Wartzok, and J. H. Johnson. 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 +1pl.

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., P. Tyack, K. E. Moore, and J. E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America 82(6):1901-1912.

Watters, D. L., M. M. Yoklavich, M. S. Love, and D. M. Schroeder. 2010. Assessing marine debris in deep seafloor habitats off California. Marine Pollution Bulletin 60:131-138.

Watwood, S. L., P. J. O. Miller, M. Johnson, P. T. Madsen, and P. L. Tyack. 2006. Deep-diving foraging behaviour of sperm whales (*Physeter macrocephalus*). Journal of Animal Ecology 75:814-825.

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., 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.

Weilgart, L. S., H. Whitehead, S. Carler, and C. W. Clark. 1993. Variations in the vocal repertoires of sperm whales (Physeter macrocephalus) with geographic area and year. Tenth Biennial Conference on the Biology of Marine Mammals, 11-15 November Galveston TX. p.112.

Weinrich, M. T., J. Bove, and N. Miller. 1993. Return and survival of humpback whale (*Megaptera novaeangliae*) calves born to a single female in three consecutive years. Marine Mammal Science 9(3):325-328.

Weinrich, M. T., and A. E. Kuhlberg. 1991. Short-term association patterns of humpback whale (Megaptera novaeangliae) groups on their feeding grounds in the southern Gulf of Maine. Canadian Journal of Zoology 69(12):3005-3011.

Weinrich, M. T., R. H. Lambertsen, C. S. Baker, M. R. Schilling, and C. R. Belt. 1991a. Behavioural responses of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine to biopsy sampling. Report of the International Whaling Commission Special Issue 13:91-97.

Weinrich, M. T., R. H. Lambertsen, C. S. Baker, M. R. Schilling, and C. R. Belt. 1991b. Behavioural responses of humpback whales (Megaptera novaeangliae) in the southern Gulf of Maine to biopsy sampling. Report of the International Whaling Commission Special Issue 13:91-97.

Weinrich, M. T., and coauthors. 1992a. Behavioral reactions of humpback whales *Megaptera novaeangliae* to biopsy procedures. Fishery Bulletin 90(3):588-598.

Weinrich, M. T., and coauthors. 1992b. Behavioral reactions of humpback whales, Megaptera novaeangliae, to biopsy procedures. Fishery Bulletin 90(3):588-598.

Weir, C. R., A. Frantzis, P. Alexiadou, and J. C. Goold. 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., W. S. D. Wilcock, and D. C. Soule. 2013. Source levels of fin whale 20Hz pulses measured in the Northeast Pacific Ocean. Journal of the Acoustical Society of America 133(2):741-749.

Weller, D. 2008. Report of the large whale tagging workshop. U.S. Marine Mammal Commission and U.S. National Marine Fisheries Service, San Diego, California.

Weller, D. W., and coauthors. 2013. Report of the National Marine Fisheries Service gray whale stock identification workshop. National Marine Fisheries Service Gray Whale Stock Identification Workshop. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Weller, D. W., and coauthors. 2005. Status of western gray whales off northeastern Sakhalin Island, Russia, in 2004. Unpublished paper to the IWC Scientific Committee. 10 pp. Ulsan, Korea, June (SC/57/BRG1).

Weller, D. W., and coauthors. 2006. Status of western gray whales off northeastern Sakhalin Island, Russia, in 2005. Unpublished paper to the IWC Scientific Committee. 10 pp. St Kitts and Nevis, West Indies, June (SC/58/BRG3).

Weller, D. W., and coauthors. 2012. Movements of gray whales between the western and eastern North Pacific. Endangered Species Research 18:193-199.

Weller, D. W., and coauthors. 1996. Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico. Marine Mammal Science 12(4):588-594.

Wells, J. V., and M. E. Richmond. 1995. Populations, metapopulations, and species populations: What are they and who should care? Wildlife Society Bulletin 23(3):458-462.

Whitehead, H. 1995. Status of Pacific sperm whale stocks before modern whaling. Report of the International Whaling Commission 45:407-412.

Whitehead, H. 2002a. Estimates of the current global population size and historical trajectory for sperm whales. Marine Ecology Progress Series 242:295-304.

Whitehead, H. 2002b. Sperm whale *Physeter macrocephalus*. Pages 1165-1172 *in* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of Marine Mammals. Academic Press, San Diego, California.

Whitehead, H. 2003. Sperm whales: social evolution in the ocean. University of Chicago Press, Chicago, Illinois. 431p.

Whitehead, H. 2008. Social and cultural evolution in the ocean: Convergences and contrasts with terrestrial systems. The Deep Structure of Biology: Is Convergence Sufficiently Ubiquitous to Give a Directional Signal? p.143-160. Simon conway Morris (ed.). Templeton Foundation Press, West Conshohocken, Pennsylvania. ISBN 978-1-59947-138-9. 256pp.

Whitehead, H., and coauthors. 2012. Multilevel societies of female sperm whales (*Physeter macrocephalus*) in the Atlantic and Pacific: Why are they so different? International Journal of Primatology 33(5):1142-1164.

Whitehead, H., and T. Arnbom. 1987. Social organization of sperm whales off the Galapagos Islands, February-April 1985. Canadian Journal of Zoology 65(4):913-919.

Whitehead, H., A. Coakes, N. Jaquet, and S. Lusseau. 2008. Movements of sperm whales in the tropical Pacific. Marine Ecology Progress Series 361:291-300.

Whitehead, H., J. Gordon, E. A. Mathews, and K. R. Richard. 1990. Obtaining skin samples from living sperm whales. Marine Mammal Science 6(4):316-326.

Whitehead, H., and S. L. Mesnick. 2003. Social structure and effects of differential removals by sex in sperm whales: Methodology. Unpublished paper to the IWC Scientific Committee. 12 pp. Berlin, May (SC/55/O12).

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., E. M. Oleson, M. A. McDonald, and J. A. Hildebrand. 2005. Blue whale (Balaenoptera musculus) diel call patterns offshore of southern California. Aquatic Mammals 31(2):161-168.

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon. 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.

Williams, R., and coauthors. 2013. Evidence for density-dependent changes in body condition and pregnancy rate of North Atlantic fin whales over four decades of varying environmental conditions. International Council For the Exploration of the Seas Journal of Marine Science 70(6):1273-1280.

Williams, R. M., A. W. Trites, and D. E. Bain. 2002. Behavioral responses of killer whales (*Orcinus orca*) to whale-watching boats: Opportunistic observations and experimental approaches. Journal of Zoology 256(2):255-270.

Winn, H. E., P. J. Perkins, and T. C. Poulter. 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.

Winn, H. E., and N. E. Reichley. 1985. Humpback whale - *Megaptera novaeangliae*. Pages 241-274 *in* S. H. Ridgway, and S. R. Harrison, editors. Handbook of Marine Mammals, volume 3 The Sirenians and Baleen Whales. Academic Press, London.

Wise, J. P., Sr., and coauthors. 2009. A global assessment of chromium pollution using sperm whales (Physeter macrocephalus) as an indicator species. Chemosphere 75(11):1461-1467.

Witteveen, B. H., R. J. Foy, K. M. Wynne, and Y. Tremblay. 2008. Investigation of foraging habits and prey selection by humpback whales (*Megaptera novaeangliae*) using acoustic tags and concurrent fish surveys. Marine Mammal Science 24(3):516-534.

Witteveen, B. H., and coauthors. 2011. Trophic levels of North Pacific humpback whales (*Megaptera novaeangliae*) through analysis of stable isotopes: Implications on prey and resource quality. Aquatic Mammals 37(2):101-110.

Wormuth, J. H., P. H. Ressler, R. B. Cady, and E. J. Harris. 2000. Zooplankton and micronekton in cyclones and anticyclones in the northeast Gulf of Mexico. Gulf of Mexico Science 18(1):23-34.

Wright, A. J. 2005. Lunar cycles and sperm whale (Physeter macrocephalus) strandings on the north Atlantic coastlines of the British isles and eastern Canada. Marine Mammal Science 21(1):145-149.

Würsig, B., T. A. Jefferson, and D. J. Schmidly. 2000. The marine mammals of the Gulf of Mexico.Texas A&M University Press, College Station. 232p.

Wursig, B., S. K. Lynn, T. A. Jefferson, and K. D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24(1):41-50.

Wynne, K., R. J. Foy, and L. Buck. 2005. Gulf apex predator-prey study. University of Alaska, Kodiak, Alaska.

Yablokov, A. V., and V. A. Zemsky. 2000. Soviet whaling data (1949-1979). Center for Russian Environmental Policy, Moscow.

Yablokov, A. V., V. A. Zemsky, Y. A. Mikhalev, V. V. Tormosov, and A. A. Berzin. 1998. Data on Soviet whaling in the Antarctic in 1947–1972 (population aspects). Russian Journal of Ecology 29:38–42.

Yochem, P. K., and S. Leatherwood. 1985. Blue whale *Balaenoptera musculus* (Linnaeus, 1758). Pages 193-240 *in* S. H. Ridgway, and R. Harrison, editors. Handbook of Marine Mammals, volume 3: The Sirenians and Baleen Whales. Academic Press, London.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. Deep-Sea Research I 53:1772-1790.

Zoidis, A. M., and coauthors. 2008. Vocalizations produced by humpback whale (*Megaptera novaeangliae*) calves recorded in Hawaii. The Journal of the Acoustical Society of America 123(3):1737-1746.