ENVIRONMENTAL ASSESSMENT

ON THE EFFECTS OF SCIENTIFIC RESEARCH ACTIVITIES ASSOCIATED WITH DEVELOPMENT OF A LOW-POWER HIGH-FREQUENCY SONAR SYSTEM TO DETECT MARINE MAMMALS

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Abstract: The National Marine Fisheries Service (NMFS), Office of Protected Resources, proposes to issue a scientific research permit for takes of marine mammals in the wild, pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 et seq.). The primary objective of the proposed action is to validate and improve low-power high-frequency sonar systems as a tool for reliably detecting marine mammals that might otherwise be adversely affected by potentially harmful industrial and military operations. Scientific research permits are generally categorically excluded from the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 et seq.) requirements to prepare an environmental assessment (EA) or environmental impact statement (EIS) (NAO 216-6). NMFS previously categorically excluded issuance of a scientific research permit for a similar study. The permit was permanently enjoined by a Federal court prior to initiation of any research activities because the court found that NMFS incorrectly invoked a categorical exclusion in issuing the permit Therefore, this document examines whether significant environmental impacts could result from issuance of the proposed scientific research permit or any of the alternatives identified as reasonable.

CHAPTER 1 PURPOSE OF AND NEED FOR ACTION

1.1 Description of Action

In response to receipt of an application from Dr. Peter J. Stein, Scientific Solutions, Inc., Nashua, New Hampshire (File No. 1048-1717), NMFS proposes to issue a scientific research permit for "takes"[1] by "level B harassment"[2] of marine mammals in the wild pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 et seq.).

The scientific research activity proposed by Dr. Stein is to expose gray whales (*Eschrtictius robustus*) migrating offshore of central California (see Figure 14 in application for map with coordinates) to low-powered high-frequency active sonar, henceforth referred to as "whale finder sonar systems", while simultaneously recording any reactions of the animals to the sound. In addition to gray whales, which are not listed under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.), other marine animals may be unintentionally exposed to the sonar. Dr Stein's application also requests authorization for unintentional "takes" of several species of non-target marine mammals that may be within the range of the whale finder sonar systems. The objectives of the proposed research are to gather data on the sonar reflectivity (the "echo") of whales, determine the probability of detection out to one mile, and determine what, if any, reaction the animals may have to high frequency active sonars designed to detect marine mammals. The purpose of the proposed research is to validate and improve the ability of whale-finder sonar systems to detect marine mammals without adversely affecting them.

1.1.1 Background

There is evidence that some anthropogenic sounds can disturb marine mammals by interfering with their communication, echolocation, or other important natural sounds. In addition, public concern for the protection of marine mammals from underwater anthropogenic noise has increased over the last few decades. Largely as a result of this increased concern about the potential effects of anthropogenic noise on marine mammals, numerous government and private organizations around the world have developed programs to research the issue. Shipping, marine geophysical surveys, oil and gas drilling, use of explosives for construction, demolition or military ordnance exercises, and some high-power sonar are among the human activities in the ocean that could affect marine mammals by increasing the amount of sound to which they are exposed. High-powered low-frequency sound sources such as air-gun arrays commonly

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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."

2 "Harass" is defined by regulation (50 CFR §216.3) as "Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B harassment)."

employed in oceanographic and geophysical research are becoming more pervasive. Two hundred vessels worldwide tow seismic arrays and over 200,000 miles are surveyed each year in this manner in the Gulf of Mexico alone (MMS data). However, shipping is the overwhelmingly dominant source of manmade noise in the ocean (Green *et al*., 1994). It is estimated that ambient noise levels in the ocean at one location off California increased by 10 dB between the 1960s to the 1990's, largely due to increases in commercial shipping, including the advent of "supertankers" (Andrew *et al*., 2002).

There is a zone of potential impact around high energy sound sources where physiological damage (injury) can occur. Depending on the energy release, this zone can extend out several hundred meters from the source. If the source is anthropogenic and marine mammals vulnerable to injury from these sounds could reliably be detected prior to entering this danger zone, the activity could be halted and injury averted.

Current techniques for detection of marine mammals include passive acoustics (listening for their vocalizations) and visual monitoring. Neither of these methods is reliable under all conditions. For example, some species of marine mammals vocalize far less frequently than others, making their detection by passive acoustics less likely. Also, marine mammals spend a substantial portion of their time below the surface where they cannot be detected. Further, visual detection of marine mammals is limited to daylight hours, good visibility (*e.g*., no fog), and relatively calm sea states. However, many high energy anthropogenic sounds may not be similarly limited.

There is a demonstrated need for more reliable methods of detecting submerged marine mammals before they enter what Dr. Stein refers to as acoustic "danger zones" where injury is possible Dr. Stein and his associates are developing a system for the detection of marine mammals that integrates passive acoustic detection, active acoustic detection, a statistical database of marine mammal distributions, and sonic dosage modeling (to predict the effects of given sound characteristics on an individual). The active acoustic component of the system needs to be validated through field tests with marine mammals. Gray whales migrating in California waters were chosen as the target species because they are not listed as threatened or endangered, their population is healthy, and the nature of their southbound migration (near shore, fairly predictable in time, large numbers of animals) means a large amount of data can be collected in a very short period of time.

1.1.2 Purpose and Need

The primary purpose of the proposed permit is to authorize "takes" by "level B harassment" of marine mammals, including endangered species, for scientific research to validate the whale-finder sonar systems. The need for the proposed action arises from NMFS' mandates under the MMPA and ESA. Specifically, NMFS has a responsibility to implement both the MMPA and the ESA to protect, conserve, and recover marine mammals and threatened and endangered species under its jurisdiction. The MMPA and ESA prohibit takes of marine mammals and threatened and endangered species, respectively, with only a few very specific exceptions, including for scientific research and enhancement purposes. Permit issuance criteria require that research activities are consistent with the purposes and polices of these Acts and will not have a significant adverse impact on the species or stock.

1.1.3 Objectives

The objective of the proposed research is to further development of a low-power high-frequency sonar system that could be used to reliably detect marine mammals at risk of injury from human activities. As such, issuance of the permit would contribute to resolving conservation problems for these species.

1.2 Other EA/EIS that Influence Scope of this EA

In response to an application (Permit No. 981-1578) from Dr. Peter Tyack, Woods Hole Oceanographic Institute, for a permit to conduct research involving exposure of marine mammals to mid- and high-frequency sound, NMFS prepared an Environmental Assessment (EA) on the effects of controlled exposure of sound on the behavior of various species of marine mammals (NMFS 2000). The primary research objective was to determine what characteristics of exposure to specific sounds evoke minor behavioral responses in marine mammals. The EA examined the environmental consequences of two alternatives: No Action (denial of the permit) and the Proposed Action (permit issuance), which included mitigation measures that would be implemented as part of the permit. The specific playback protocols examined involved exposure of animals to playbacks of low-power, mid- to high-frequency active sonar designed to detect marine mammals. The proposed received levels for the playbacks were not to exceed 160 dB. Other characteristics of the signals included bandwidths of 100, 200, and 400 Hz; pulse durations of 50, 100, 200, and 400 milliseconds; chirp upsweeps centered at 1, 2.5, 4, 8, and 12 kHz; and a pulse repetition rate of not more than one ping per minute. A Finding of No Significant Impact (FONSI) was signed on August 31, 2000, based on information indicating that the short-term impacts of conducting acoustic playback experiments on cetaceans would not result in more than a temporary shift in the hearing thresholds of some individual cetaceans, and that changes in the behavior (to avoid the sounds) of individual animals were expected to have negligible impacts on the animals, and the species.

A second EA was prepared on the effects of controlled exposure of sound on the behavior of various species of marine mammals in response to another application submitted by Dr. Tyack (NMFS 2003). The principal differences in the proposed action for the second EA compared to the first were an expanded geographic scope and an increase in the sound levels produced. The second application and EA were prepared following litigation involving Dr. Tyack's original permit (No. 981-1578), in which the court invalidated amendments to the permit that were not specifically analyzed in the first EA (Hawaii County Green Party vs. Evans, C-03-0078-SC, U.S. District Court, Northern District of California). A FONSI for the second EA was signed in June 2003, based on information indicating that the short-term impacts of conducting acoustic playback experiments on cetaceans would not result in more than a temporary shift in the hearing thresholds of some individual cetaceans, and that changes in the behavior (to avoid the sounds) of individual animals were expected to have negligible impacts on the animals, and the species.

Although they were not for the same geographic areas as the proposed action (issuance of a permit for use of the whale-finder sonar systems), analysis of the information in these EAs demonstrated that the potential impacts of the proposed action would be limited to the biological environment, and, more specifically, to marine organisms within range of the sounds from whale-finder sonar systems. Based on the information analyzed in these EAs there are not likely to be any measurable impacts from the proposed action on social or economic aspects, nor on the physical environment. Similarly, invertebrates, fish, sea turtles, and sea birds that may be within the range of the sounds from the whale-finder sonar systems are not likely to be affected, for reasons discussed in these previous EAs, and summarized in Chapters 3 and 4 below. Thus, the issues within the scope of this EA are primarily related to the potential impacts of the proposed action on marine organisms, especially marine mammals.

1.3 Decision and other Agencies Involved in this Analysis

NMFS must decide whether authorizing the new permit would be consistent with the purposes and policies of the MMPA, ESA and their implementing regulations, including making certain the permitted activities will not operate to the disadvantage of any marine mammal species. Pursuant to 50 CFR §216.33 (d)(2), NMFS has consulted with the Marine Mammal Commission (MMC) in reviewing the application for a scientific research permit under the MMPA. The application and draft EA were sent to the MMC for review at the same time notice was published in the Federal Register that the application and draft EA were available for public comment. After review of the application and draft EA, the MMC recommended approval of the permit and, in their comments on the application, stated that "the proposed research is important and will contribute to our knowledge concerning the efficacy of whale finding sonar and its effects on marine mammals."

Because the threatened southern sea otter (*Enhydra lutris*), which may be present in the proposed action area, is under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), NMFS consulted with USFWS on the proposed issuance of the permit. After review of the application, draft EA and other relevant information, USFWS concurred with NOAO Fisheries determination that issuance of the permit was not likely to adversely affect southern sea otters.

No other Federal, state or local agencies are involved in the proposed action. During the public comment period for the application and draft EA, a member of the public suggested that the California Coastal Commission (CCC) should have been provided the opportunity to be involved (see Appendix C; comments from Sinkin, dated December 5, 2003). NMFS was in communication with a representative of CCC throughout the comment period. The CCC chose not to request permission from NOAA's Office of Ocean and Coastal Resource Management to review the application because the CCC has not chosen to exert jurisdiction over the type of activity proposed by Dr. Stein. It is not clear that use of low-power high-frequency sonars would meet the legal definition (under state law) of development.

1.4 Scoping Summary

The purpose of scoping is to identify the issues to be addressed and the significant issues related to the proposed action, as well as identify and eliminate from detailed study the issues that are not significant or that have been covered by prior environmental review. An additional purpose of the scoping process is to identify the concerns of the affected public and Federal agencies, states, and Indian tribes. CEQ regulations implementing the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 et seq.) do not require that a draft EA be made available for public comment as part of the scoping process. The MMPA and its implementing regulations governing issuance of special exception permits for scientific research (50 C.F.R. §216.33) require that, upon receipt of a valid and complete application for a permit, and the preparation of any NEPA documentation that has been determined initially to be required, NMFS publish a notice of receipt in the Federal Register. The notice summarizes the purpose of the requested permit, includes a statement about whether an EA or EIS was prepared, and invites interested parties to submit written comments concerning the application. A Notice of Receipt of the application and availability of a draft EA was published in the Federal Register, announcing the availability of both documents for public comment (68 FR 62563, November 5, 2003). In addition, NMFS held a public meeting during the comment period "to inform interested parties of the proposed research and solicit comments on the application and accompanying draft EA." (68 FR 64865, November 17, 2003) A court reporter was present during the meeting to record the proceedings verbatim. Any comments made by the public during the meeting would have been treated as written comments submitted during the comment period. No public comments were offered during the meeting.

Written comments on the application and/or draft Environmental Assessment were received from the Natural Resources Defense Council (NRDC), the American Cetacean Society (ACS), the Whale and Dolphin Conservation Society (WDCS), and Mr. Lanny Sinkin. The WDCS comments were received after the close of the public comment period but NOAA Fisheries has chosen to consider them in making its decision on Dr. Stein's permit application. Copies of all comments are attached in Appendix C. The main issues raised by ACS, WDCS, and Mr. Sinkin were regarding the status of the gray whale population and whether there is a potential for injury of gray whales or other marine life from the proposed study. The NRDC did not comment on the substance of the application or draft EA but did express concern that NOAA Fisheries would apply the new definition of harassment (Pub. L. No. 108-136, §319(a) (2003)) to the proposed research.[3]

Scientific research permits are generally categorically excluded from NEPA requirements to prepare an environmental assessment (EA) or environmental impact statement (EIS) (NAO 216-6). NMFS previously categorically excluded issuance of a scientific research permit for a similar study (Permit No. 981-1578-03: Principal Investigator, Dr. Peter Tyack). The permit was permanently enjoined by a Federal court prior to initiation of any research activities because the court found that NMFS incorrectly invoked a categorical exclusion in issuing the permit (Hawaii

3 During the comment period for this application, another definition of harassment under the MMPA became a law (Pub. L. No. 108-136, §319(a) (2003)). This new law states that: "in the case of a military readiness activity (as defined in section 315(f) of Public Law 107-314; 16 U.S.C. 703 note) or a scientific research activity conducted by or on behalf of the Federal Government consistent with section 104(c)(3), the term 'harassment' means——"(i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild; or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered." NMFS is in the process of determining the implications of this new law for scientific research permits under section 104 of the MMPA. While the new definition may apply to the proposed action, given that the permit application was pending at the time of the change in the law, NMFS is processing the application under the definition of harassment in the MMPA (16 U.S.C. 1362 3(18)(A)).

County Green Party vs. Evans, C-03-0078-SC, U.S. District Court, Northern District of California).

This EA, in conjunction with consultation under Section 7 of the ESA, examines whether the potential impacts of the proposed action on a limited number of marine mammals are likely to result in an adverse effect on the species to which the individuals belong. This EA will also examine the potential impacts of the proposed action on the human environment, including whether issuance of the permit in the proposed action would, in conjunction with other related actions, result in cumulatively significant effects.

1.5 Federal Permits, Licenses, and Entitlements Necessary to Implementation of the Action

A moratorium on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas was established with passage of the MMPA in 1972. The MMPA provides that this moratorium on taking of marine mammals can be waived for specific purposes, if the taking will not disadvantage the affected species or stock. Section 104 of the MMPA allows for issuance of permits to take marine mammals for the purposes of scientific research or to enhance the survival or recovery of a species or stock. These permits must specify the number and species of animals that can be taken, and designate the manner (method, dates, locations, etc.) in which the takes may occur. Section 9 of the ESA, as amended, and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Permits to take ESA-listed species for scientific purposes (or for the purpose of enhancing the propagation or survival of the species) may be granted pursuant to Section 10 of the ESA and in accordance with NMFS' implementing regulations. See Appendix A for a brief overview of the process for obtaining a NMFS Scientific Research Permit under MMPA and ESA.

CHAPTER 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the range of potential actions (alternatives) determined reasonable with respect to achieving the stated objective, as well as alternatives eliminated from detailed study. This chapter also summarizes the expected outputs and any related mitigation of each alternative. One alternative is the No Action alternative, or Status Quo alternative, where the proposed permit would not be issued. The Status Quo is the baseline for rest of the analyses. "No Action" does not mean that there will be no environmental consequences because there may be existing activities that have an impact on the environment. However, under the status quo alternative the baseline remains unaltered by the proposed action. In general, there can be impacts on the environment under the No Action alternative that result from not implementing an action that would otherwise have mitigated or minimized impacts from other human actions. The Proposed Action alternative represents the research proposed in the submitted application with the addition of special terms and conditions standard in NMFS scientific research permits and other conditions determined appropriate by NMFS. Another alternative that authorized the proposed research, but required the applicant to use lower sound levels was eliminated because it would not facilitate the development of a whale-finding sonar that can be used to reliably detect marine mammals underwater.

2.1 Alternative 1 – No Action

Under this alternative, which is the "no action" alternative, a new permit for scientific research to validate the use of whale finder sonar systems in detecting marine mammals would not be issued at this time. Some activities that may be affecting the baseline are discussed in section 4.7 and include vessel interactions, other marine mammal research activities, habitat degradation (pollution) and anthropogenic noise from airplanes, helicopters, recreational boating and commercial shipping. It is likely that many of the recreational and all of the commercial vessels would be operating high-frequency sonars in the form of fish-finders or depth-sounders.

Dr. Peter Tyack currently has a permit (Permit No. 981-1707) that authorizes takes of marine mammals during testing of another whale finder sonar. This permit would remain in effect, but it does not involve gray whales offshore of California. The Proposed action would allow for a larger sample size in a shorter time frame for validation studies. Under the No Action alternative, the effects on a limited number of marine mammals that might result from exposure to the whale-finder sonar sounds of the Proposed Action would not occur.

Although the action area for the proposed study encompasses a very small portion of ocean, the whale-finder sonars, if proven reliable, could have a much wider geographic application. The potential impacts of a geographical expansion in the use of whale-finder sonars as mitigation for other activities is beyond the scope of this document. However, without availability of a reliable whale-finder sonar, some of the human acoustic activities thought to pose the greatest acoustic risk to marine mammals would continue to rely upon less accurate visual and passive acoustic methods for detection of marine mammals.

2.2 Alternative 2 – Proposed Action

Under this alternative, the Proposed Action, a five-year scientific research permit would be issued to Dr. Stein authorizing takes of marine mammals by Level B harassment from exposure to sounds generated by the whale finder sonar systems as described in the application. The operating frequency of the system would be greater than 20 kHz with a maximum source level at or less than 220 dB re 1µPa at 1 m in individual pulses less than one second for a duty cycle (time on over total time) of less than 10%.[4] Although no injury or hearing loss is possible from the whale-finder sonars, the system would be operated using mitigation measures including a ramp-up procedure when first turned on so that the source level starts no higher than 180 dB re 1µPa at 1 m and increases no faster than 5 dB per minute. This would allow any marine animals in the action area that can detect the sound to, if they choose, move away before the sound reaches the maximum source level.

Under the Proposed Action alternative, a permit would authorize the intentional exposure of gray whales to the whale finder sonar. A permit would also authorize unintentional exposure of a number of other marine mammals under NMFS jurisdiction to the whale finder sonar, as outlined in Table 1 below. Note that southern sea otters are under the jurisdiction of USFWS, rather than NMFS. Through the ESA Section 7 consultation process it has been determined that the proposed action is not likely to adversely affect southern sea otters (see section 4.4).

Two separate whale finder sonar systems developed by Dr. Stein would be tested under the Proposed Action. One whale finder sonar, the Marine Mammal Active Sonar Test (MAST) Mechanical System, is a version of the High Frequency Marine Mammal Mitigation Sonar (HF/M3) currently deployed as part of the SURTASS LFA (Surface Towed Array Surveillance System Low Frequency Active) sonar system. In addition to MAST, the Integrated Marine Mammal Monitoring and Protection System (IMAPS) would be tested during the proposed study. The active component of IMAPS is a relatively expensive phased array system using a vertical line array source and 60 receive line arrays surrounding a cylindrical steel baffle. Thus, IMAPS works as both active and passive receivers. In order to fully develop IMAPS it is necessary to know what a whale "looks like" to the sonar, and in much more detail then has ever been collected. Thus, one of the main purposes of the proposed study is to collect data on the sonar's detection, classification, and tracking of a large number of objects known to be whales.

These whale-finder sonars are similar in frequency and output power to fish-finders, depth sounders, and side scan sonars. This means that the frequency of operation and the acoustic output power is similar. The MAST mechanical system operates between 30 and 40 kHz and has a maximum instantaneous output power around 1 kilowatt.[5] The IMAPS system operates between 20 and 30 kHz and has a maximum power output of 3 kilowatts. As an example, Furuno/Raytheon (www.furuno.com) sells fish-finders that operate between 28 kHz and 235 kHz with a maximum instantaneous output power up to 3 kilowatts. There are many such fish-finders, depth sounders, and side scan sonars that operate between 3 kHz and 250 kHz with similar acoustic output powers.

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4 With a 10% duty cycle and operations limited to optimal daylight hours, the maximum amount of time the sonar sounds would be broadcast during a 6-8 hour day is 36-48 minutes (i.e., 10% of 360 minutes).

5 As a point of reference, the average hair dryer has a power output near 1 kilowatt and commercially available toaster ovens operate slightly above 1 kilowatt.

The main difference between these commercially available devices and the "whale-finder" sonars is sophistication, not the loudness or potential for adverse effects of the sonar. The goal of the proposed study is to develop systems that detect whales out to 1 mile, which is well beyond the range of commercially available fish-finders. Also, fish-finders do not look in all directions, while the whale-finder systems are designed to look all around. The whale-finders being developed must also have a very high chance of detecting and identifying a marine mammal while also having a very low chance of mistaking another object for a marine mammal. If a fish-finder does not detect a single fish or mistakes some other object for a fish, there's no real harm. However, since the purpose of the whale-finder is to protect marine mammals, one would not want to miss a single marine mammal. In addition, it would not be acceptable to be constantly stopping an operation when just anything is detected.

The whale finder sonar systems validation study would be conducted off the central California coast, near Diablo Canyon, during a three to four week period between December and February of each year. This corresponds with the southbound migration of gray whales. During the study, a research vessel would be moored approximately one mile offshore near the center of the migration route and the whale finder sonar systems would be deployed off the vessel or moored nearby. Visual observers would be located at two separate stations onshore, tracking the whales using theodolites. There would be additional observers onboard the research vessel. Although the study's timeframe may run for as long as 30 days, the sonar would only be operated for up to 120 hours (20 days at a maximum of six hours per day).[6] During the peak of the gray whale's southbound migration an average of 10 whales per hour is expected to pass by the moored research vessel. This equates to approximately 1200 gray whales, or approximately 7% of the gray whale population passing through the action area during the course of the study. As they pass by the research vessel at different angles, individual whales would be "visualized" by the whale finder sonar systems, which would allow Dr. Stein to thoroughly analyze differences in animal reflectivity as a function of which way they are pointing relative to the sonar. Although no behavioral responses are likely because most, if not all, of the sound from the whale-finder sonars would be inaudible to gray whales, both the observers on the research vessel and those onshore would also be watching for any changes in animals' behavior.

Table 1. List of species that may be present in the action area. Note that, for some species, maximum numbers of individuals that may be ensonified (this means exposed to the whale-finder sonar sounds, but does not necessarily equal affected) under the Proposed Action may not correspond to the numbers in Dr. Stein's application. Based on stock abundance and distribution information, as well as the season, duration, probable sound propagation for the proposed action, and auditory capabilities of various species (measured or predicted), NMFS has modified the numbers for some species compared to the applicaiton. It is not possible to anticipate the actual number of individuals of a given species that could be present during the proposed study. However, estimates can be made based on population estimates, previous studies, and the time of year. The table also indicates the number of "takes" by level B harassment that would be authorized. In all cases, these numbers represent conservative estimates in that they define an upper limit of probability of occurrence, but probably overestimate the number of individuals

6 Note that, with the 10% duty cycle, this actually means the whale-finder sonar would only be producing sounds for a total of 12 hours over a three to four week span (*i.e.*, 10% of 120 hours = 12 hours).

that would actually be harassed (as evidenced by avoidance or other behaviors indicative of disturbance) by the proposed action. In other words, the number is an overestimate. Given the brief duty cycle and small zone of audibility, it is not likely that all 1200 gray whales migrating through the area over the time of the study would be exposed. Note that no "takes" by injury or mortality have been requested nor are any anticipated.

Species	Stock[1]	Max. # individuals exposed[2]	Species/stock status under MMPA/ESA/CITES[3]	Minimum population estimate[4]
Gray whale (*Eschrictius robustus*)	Eastern Pacific	1200	Depleted/Recovered/I	24,477
Harbor porpoise (*Phocoena phocoena*)	Central CA	150	none/none/II	5,563
Dall's porpoise (*Phocoenoides dalli*)	CA/OR/WA	150	none/none/II	81,866
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	CA/OR/WA	400	none/none/II	17,475
Bottlenose dolphin (*Tursiops truncatus*)	CA coastal	150	none/none/II	154
Risso's dolphin (*Grampus griseus*)	CA/OR/WA	2000	none/none/II	13,079
Short-beaked common dolphin (*Delphinus delphis*)	CA/OR/WA	2000	none/none/II	318,795
Northern right whale dolphin (*Lissodephis borelais*)	CA/OR/WA	1200	none/none/II	15,080
Killer whale (*Orcinus orca*)	CA/OR/WA	200	none/none/II	436
Short-finned pilot whale (*Globicephala macrorhynchus*)	CA/OR/WA	200	none/none/II	717
Baird's beaked whale (*Berardius bairdii*)	CA/OR/WA	30	none/none/I	313
Mesoplodont beaked whales (*Mesoplodon* spp.)	CA/OR/WA	30	none/none/II	2,734
Cuvier's beaked whale (*Ziphius cavirostris*)	CA/OR/WA	30	none/none/II	4,309
California sea lion (*Zalophus californianus*)	U.S.	500	none	109,854
Harbor seal (*Phoca vitulina*)	CA	500	none	27,962
Northern elephant seal (Mirounga angustirostris)	CA breeding	500	none	60,547

Species	Stock[1]	Max. # individuals exposed	Species/stock status under MMPA/ESA/CITES	Minimum population estimate
Northern fur seal (*Callorhinus ursinus*)	San Miguel Island	200	none	2,336
Southern sea otter (*Enhydra lutris*)	CA	100[5]	Depleted/Threatened/I	2,359

1. "Stock" refers to the management units as identified by NMFS.
2. Maximum number of individuals exposed annually refers to the number of individual animals of a given species or stock that may be within the action area per year during the proposed study.
3. Under the MMPA, a species or stock can be listed as depleted (below optimum sustainable population). A species or Distinct Population Segment may be listed as threatened or endangered under the ESA. Species can be listed on Appendix I or II of CITES.
4. Minimum range-wide population estimates from NMFS and USFWS most recent stock assessment reports.
5. Note that sea otters are under the jurisdiction of USFWS, which has concurred with NMFS' determination that the proposed action is not likely to adverse affect sea otters.

2.3 Alternatives Considered but Eliminated from Detailed Study

An alternative that would authorize the proposed validation study of the whale finder sonar systems using lower source levels was considered. However, previous tests of similar whale finder sonar systems with source levels of 160-200 dB re 1 µPa at 1 m failed to yield any echoes from target whales (see annual reports submitted by Dr. Tyack for Permit No. 981-1578). To be useful as a mitigation tool, the whale-finding sonar must be able to detect the sound echoes bouncing off the whale's body, just as a fish finder shows a display of where the fish are located. The maximum source level of 220 dB re 1µPa at 1 m was reached through balancing a variety of engineering issues such as maximum detection range, available power amplifier and transducer designs, and clutter versus ambient and electrical noise. This source level was further chosen because, at the frequencies used, the sound level is certain to drop to 180 dB re 1µPa within 100 m. Since no echoes were obtained at the lower source dB levels in previous studies under a permit held by Dr. Tyack (Permit No. 981-1578), a higher source level is required to continue testing the whale finding sonar. Therefore, this alternative was eliminated from further consideration because continuing to use lower source levels shown to be unsuccessful would not meet the objectives of this research to develop a tool for detecting animals underwater.

CHAPTER 3 AFFECTED ENVIRONMENT

This chapter presents baseline information necessary for consideration of the alternatives, and describes the resources that would be affected by the alternatives, as well as environmental components that would affect the alternatives if they were to be implemented. The effects of the alternatives are discussed in Chapter 4.

3.1 Social and Economic

Although economic and social factors are listed in the definition of effects in the NEPA regulations, the definition of human environment states that "economic and social effects are not intended by themselves to require preparation of an EIS." However, an EIS or EA must include a discussion of a proposed action's economic and social effects when these effects are related to effects on the natural or physical environment. The social and economic effects of the Proposed Action mainly involve the effects on the people involved in the research, as well as any industries that support the research, such as charter vessels, and suppliers of equipment needed to accomplish the research. There are no significant social or economic impacts of the Proposed Action interrelated with significant natural or physical environmental effects. Thus, the EA does not include any further analysis of social or economic effects of the proposed action.

3.2 Physical Environment

The action area for the Proposed Action is a small segment of water offshore of central California. It originates at the source of the whale finder sonar systems and travels outward as far as the sound can be detected by a marine organism, or approximately the point at which the sonar signal drops below ambient noise level[7]. Noise levels produced by human activities are determined not only by their acoustic power output (a function of the source level and frequency) but by local sound transmission conditions, including ambient noise levels, water depth and temperature and other variables (Richardson et al., 1995). Due to the properties of sound propagation and loss in water, sounds from the whale finder sonar systems will drop to levels of 180 dB re 1µPa within 100 m of the source. The quietest ambient noise levels anticipated for the region of the proposed study ranges from approximately 40 to 80 dB re 1μPa^2/Hz depending on winds, rain, surf conditions, boat traffic, etc. Under ideal conditions with no surface bounce losses, and with a maximum source level of 220 dB re 1µPa re 1 m and a minimum 3 kHz bandwidth, the source band level would be 220 – 10 log 3000, or 185 dB re μPa^2/Hz. This means there would have to be about 105 to 145 dB of transmission loss for the sonar signal to drop to ambient noise levels. At 20 kHz, this is approximately equal to 15 to 33 km from the source. This distance would be shorter for sounds of higher frequency. However, this maximum distance over which the whale finder sonar sounds may be above ambient does not necessarily correspond to the distance at which marine mammals would be affected. Even using the more

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7 A note on ambient noise. Because of the logarithmic nature of decibel scales, the effect of the whale finder sonar on ambient noise levels would not be directly additive. That is, at most it would increase background noise levels by 3 dB. For example, if ambient noise level was 100 dB and the received level for the whale finder sonar was 100 dB, the total ambient noise level at the point would be 103 dB. When the difference between ambient levels and the sonar sounds are greater than 6 dB, their sum is within 1 dB of the higher of the two levels.

conservative estimate of the size of the zone of audibility for the proposed study, the action area represents a tiny fraction of the total ocean environment, and a very small portion of the total migratory path of the gray whales, which extends some 8,000 km (4, 972 miles) between Alaska and Mexico.

The audibility of sounds above ambient noise level is a function of the hearing sensitivity of the organism. As discussed below, only certain marine mammals that may be within the action area are likely to be able to detect the sound produced by the whale finder sonar systems at any substantial distance from the source. Thus, the action area is effectively confined to a region of water radiating outward approximately 15 to 33 km or less from where the sonar is moored. (The source will be stationed about one mile offshore, centered at approximately 35°14'N latitude and 121°55'W longitude.) This assumes ideal conditions for sound transmission. There may be regions within this radius where, due to physical properties of the water, substrate, etc. the transmission loss is even greater and the sonar sounds would not be detectable. Further, as discussed below, whether or not a marine animal can hear the sound from the sonar does not necessarily mean it will be affected in a biologically significant manner. Therefore the effective action area, or region within which impacts may occur, may be even smaller than the physical zone of audibility. In addition, the size of the action area, particularly the zone of audibility, is very small compared to the total range of any of the marine mammal species that may be within or passing through the action area.

3.2.1 Sanctuaries, Parks, Historic Sites, etc.

There are no National Marine Sanctuaries, state or national parks, National Wildlife Refuges, or historic sites (*i.e.*, sites listed with the National Register of Historic Places) within the action area as defined above.

3.2.2 Essential Fish Habitat

Congress defined Essential Fish Habitat (EFH) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management. EFH has been designated for many of the fish species within the action area. Details of the designations and descriptions of the habitats are available in the Pacific Fishery Management Plans. Activities that have been shown to affect EFH include disturbance or destruction of habitat from stationary fishing gear, dredging and filling, agricultural and urban runoff, direct discharge, and the introduction of exotic species. None of the activities in the Proposed Action are directed at or likely to have any impact on any designated EFH.

3.2.3 Designated Critical Habitat

No critical habitat has been designated for any endangered whale species other than right whales. Right whale critical habitat has only been designated in the Atlantic Ocean, which is not within the action area for the proposed action. Critical habitat has been designated for leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles in the Atlantic, but not in the Pacific; thus there is no sea turtle critical habitat within the range of the proposed research. Critical habitat has been designated for Central California Coast

Coho salmon (*Oncorhynchus kisutch*) (50 CFR §226.210) and for a number of evolutionary significant units of salmon and steelhead (50 §CFR 226.212), however, it is all located well north of the action area.

3.3 Biological Environment

In addition to the target species, gray whales, a wide variety of marine species could be found within the action area, including other marine mammals, sea turtles, invertebrates, teleost and elasmobranch fish, and sea birds. Since merely being present within the action area does not necessarily mean a marine organism will be affected by the proposed action, the following discussion focuses not only the distribution and abundance of various species that may be present at the time of the proposed study, but also on whether or not the sounds produced by the whale finder sonar would be within the hearing range of that organism.

3.3.1 Invertebrates

A variety of invertebrates may be present within the action area including assorted mollusks, crustaceans, sponges, and jellyfish. Little is known about the importance of underwater sound in invertebrates. Many invertebrates are not capable of hearing or producing sounds; in fact, no hearing organs or vocal organs have been identified for most species. However, according to Hawkins and Myrberg (1983), it appears that some sound-producing invertebrates are capable of communicating with each other. The only invertebrates for which thresholds for hearing have been measured are cephalopods and decapods. Budelmann and Young (1994) found a threshold of 146 dB for cephalopods and Offut (1970) found a threshold of 150 dB for American lobster (*Homarus homarus*). Few invertebrates have tissues with acoustic impedance sufficiently different from seawater to pose a risk of non-auditory damage (*i.e*., from resonance). Therefore there is likely to be little risk of either auditory or non-auditory physical damage. Both Budelmann and Young (1994) and Offut (1970) found sensitivity to sounds lower in frequency than those to be transmitted in the proposed research. The thresholds are so high that these species would only be able to detect the transmissions within 1 km of the source for the whale-finder sonars. This is such a small area in which the sounds can even be detected that it is likely to have insignificant effects on invertebrate populations overall. Given the extremely short duration of time over which sounds from the whale-finder sonars would be broadcast (not more than 36 minutes in a day or a total of 12 hours in a year), and the fact that the coastal environment is already ensonfied by countless other high-frequency sonars in the form of fish-finders and depth sounders, the proposed study would contribute a negligible amount to the acoustic environment of these animals.

3.3.2 Fish

There are dozens of fish species that may occur within the action area, including anchovy, tuna, swordfish, herring, sardine, mackerel, rockfish, flatfish (e.g., sole, flounder, turbot, halibut), and six species of sharks and skates. Audiograms have been determined for over 50 fish and three shark species (Fay, 1988). The majority of acoustic data have been collected on bony fish, while virtually nothing is known of hearing in jawless fish (Popper and Fay, 1993). Myrberg (1980) states that the most important region of sound detection in most fishes rests between about 40 and 1000 Hz. Sharks generally do not detect sounds above 1 kHz and, in most cases, best sensitivity is to signals below 300 Hz (Popper and Fay, 1977). Sharks seem to be attracted to low frequency sounds which they may use as a means of locating prey. Sensitivity in lemon sharks is best at about 40 Hz (Nelson, 1967; Kelly and Nelson, 1975). Fish that have specializations to enhance their hearing sensitivity have been referred to as hearing specialists, whereas those that do not possess such capabilities are termed generalsits. The former tend to have greater sensitivity and a wider hearing bandwidth (up to 3 kHz) than the latter. The squirrelfish, for example, can detect 2 kHz sounds at 105 dB re 1 μPa. Some recent research suggests that fish such as alewives, herring, and cod are able to detect intense high frequency sounds. For example, Astrup and Møhl (1993) provide evidence that cod (*Gadus morhua)* detect short 38 kHz pulses at 194 dB re 1 μPa. Both alewives (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) form tighter schools and moved away from playback of sounds from 110-140 kHz at levels above 160 dB re 1 μPa (alewives; Dunning *et al*., 1992) to 180 dB re 1 μPa (herring; Nestler *et al*., 1992). The sound transmissions in the proposed research are lower in frequency and sound level than those sounds that elicited behavior response from fish as described above. Thus, the proposed research may not elicit any response from any fish species. However, even if fish were to show similar responses to the proposed sound transmissions, the observed responses occurred at intense (high) received levels, which in the proposed research would only occur over a very small range close to the sound source. Furthermore, ramp up procedures for the whale-finder sonar systems should allow fish that can hear and are disturbed by the sounds to move away from the sound source. As with invertebrates, the proposed study would contribute a negligible amount to the acoustic environment of fish due to the very small area in which the sounds might even be detectable and given the extremely short duration of time over which sounds from the whale-finder sonars would be broadcast (not more than 36 minutes in a day or a total of 12 hours in a year), and the fact that the coastal environment is already ensonfied by countless other high-frequency sonars in the form of fish-finders and depth sounders.

Some fish have swimbladders, which present a tissue boundary that may be affected by underwater sound, so these species are potential candidates for non-auditory acoustic damage. Since the acoustic impedance of air and water are very different, tissues at the boundary of these two impedances may become stressed and rupture. For example, a small anchovy at one atmosphere of pressure has a resonant frequency of 1275 Hz (Batzler and Pickwell 1970). However, the sounds in the proposed research are well above the frequency ranges at which fish swimbladders have demonstrated resonance. In addition, the sounds are too brief and the source levels are well below those required to set up resonance effects that may pose a risk of swimbladder damage. Thus, the proposed action would not have a substantial effect on fish with swimbladders.

3.3.3 Sea Turtles

The following species of endangered sea turtles may occur within the proposed action area, though not necessarily at the time of year of the proposed study: green, leatherback, loggerhead (*Caretta caretta*), and olive ridley (*Lepidochelys olivacea*). Sea turtles have well-developed ears, but their auditory sensitivity is poor. Several studies suggest that they can hear sounds below 1 kHz, but no evidence suggests that they can hear higher frequencies. Studies of hearing in juvenile loggerhead sea turtles suggest that they can hear frequencies between 250-750 Hz, with best hearing at 250 H (Bartol *et al*., 1999). Green turtles are most sensitive to frequencies of 300-400 Hz, but their sensitivity declines rapidly outside of this range (Ridgway *et al*., 1969). Ridgway *et al.* (1969) used aerial and mechanical stimulation to measure the cochlear response in three specimens of green sea turtle, and concluded that they have a useful hearing span of perhaps 60-1000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. One turtle with a 400 Hz frequency best hearing sensitivity showed a hearing threshold of about 64 dB in air (approximately 126 dB in water, if one corrects for the differences in acoustic impedance between air and water and the different ways sounds in air and water are referenced). Lenhardt *et al*. (1983) applied audio frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water. At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt *et al.* (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces. There are no audiogram data available for 1eatherbacks. Because they are morphologically distinct, approximating hearing thresholds from data available for the other (hard shell) species is probably inappropriate.

Although the above listed sea turtle species do occur offshore of central California, it is highly unlikely that any would be present in the action area at the time of year proposed for the study because the water temperature would be too low. Some leatherback, green and olive ridley turtles have stranded in San Luis Obispo County (the county adjacent to the waters of which the action area is a part) in December and January. However, sea turtles are also not likely to be affected because all of the energy from the whale-finding sonar systems to be tested is far enough above the hearing range of sea turtles that, even if any were present, it is not likely that these signals could be heard or would have adverse effects on sea turtles.

3.3.4 Seabirds

There are dozens of species of seabirds that may be found within the action area, including brown pelicans, boobies, storm petrels, alcids, shearwaters, gulls, and terns. Seabirds that forage for food at sea by plunging or diving beneath the surface could be exposed to underwater sound. Little is known about hearing in seabirds nor about underwater hearing in any bird species. Dooling (1978) summarizes studies of in-air hearing in birds and notes that behavioral measurements of absolute auditory sensitivity in a wide variety of birds show a region of maximum sensitivity between 1 and 5 kHz. There is no overlap between the absolute auditory sensitivity of birds (maximum sensitivity between 1 and 5 kHz) and the proposed whale-finder sonar transmissions, so it is not likely that seabirds diving near the source might hear the transmissions. Even if some diving birds were able to hear the signal, it is unlikely to have an impact because: 1) there is no evidence seabirds use underwater sound; 2) seabirds spend a small fraction of time submerged; and 3) seabirds could rapidly fly away from the area and disperse to other areas if disturbed. Once again, as mentioned with invertebrates and fish, the proposed study would contribute a negligible amount to the acoustic environment of sea birds due to the very small area in which the sounds might even be detectable and given the extremely short duration of time over which sounds from the whale-finder sonars would be broadcast (not more than 36 minutes in a day or a total of 12 hours in a year), and the fact that the coastal environment is already ensonfied by countless other high-frequency sonars in the form of fish-finders and depth sounders.

3.3.5 Marine Mammals

In addition to the marine mammals listed in the Table 1 in Section 2.2 above, other marine mammals may be present in the action area, although their occurrence is unlikely or too rare to predict, especially at the time of year of the proposed study. NMFS publishes annual stock assessment reports for the marine mammals under its jurisdiction. Except for southern sea otters, details on the distribution, abundance, productivity and annual human-caused mortality for the species listed in Table 1 above can be found in the U.S. Pacific Marine Mammal Stock Assessment reports, and the Alaska Marine Mammal Stock Assessment Reports, which are available in PDF from the NMFS website. The most current information on the status of the southern sea otter is available from the U.S. Fish and Wildlife Service, which has jurisdiction for this species. The following is a brief summary of the occurrence of select species in the proposed study area.

Baleen whales

According to the most recent final stock assessment report, the minimum population estimate[8] for the eastern North Pacific stock of **gray whales** is 24, 477 (Angliss and Lodge, 2002). This number is based on survey data through 1998. Three surveys have been conducted by NMFS between 1997 and 2002, but a revised stock assessment report with a revised minimum population estimate has not yet been released. However, Rugh et al. (in press) have submitted for publication a study of estimates of abundance of the eastern North Pacific stock of gray whales from 1997 to 2002. The abundance in 1997/98 was the highest since surveys in 1967. The abundance estimates were 29, 758 whales in 1997/98, 18,784 (95% C.I. = 15, 566 to 22, 667) in 2000/01 and 17, 614 (95% C.I. = 14, 557 to 21, 314) in 2001/2002. There is some overlap in the 95% confidence intervals for the last to surveys. The lower estimates in 2000/01 and 2001/02 are probably related to an Unusual Mortality Event (UME) that occurred in 1999/2000 in which a higher than average number of stranded gray whales was sighted along the west coast of North America (273 in '99 and 355 in '00 compared to an average of 38 in previous years). However, analysis of stranding data indicate this UME had ended by 2001. Only 21 gray whale strandings were reported in 2001, which is close to the average of 38 per year for the period of 1995-1998. During the 1999 and 2000 UME, whales were visibly thin. Whales observed during surveys since 2001 have been visibly rotund. In addition, the number of stranded animals has been lower than average since 2001 and calf counts have been high. This UME is believed to be linked to a temporary food shortage resulting from a climatic event.

Note that a UME is an acute event rather than a chronic trend, and the fact that the point estimates in 2000/01 and 2001/02 are lower than the 1997/98 estimate does not indicate a "population crash." It would be inappropriate to define a population trajectory based on three

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8 Note that a "minimum population estimate" (N_{MIN}) is not the same as a point estimate derived from a stock survey. N_{MIN} is calculated using an equation in Wade and Angliss (1997) and represents a conservative population estimate. In other words, there is a high statistical probability that there are at least as many animals as N_{MIN}. With a point estimate, there is a roughly equal probability that there are fewer animals or more animals than estimated from the survey data.

point estimates over five years for a long-lived, slow to mature species such as gray whales. Looking at the abundance surveys from 1967 to date, it appears this gray whale population is at or approaching the carrying capacity of its environment. If this is the case, it can be expected that subsequent surveys will show a trend toward a stable rather than increasing population abundance. This does not necessarily mean that counts will be the same each year. It would be natural for abundance surveys of a population at or near carrying capacity to show deviations both above and below an average value over time. In addition, depending on food and weather conditions, there may be years when many whales simply do not migrate as far south as they had in previous years. Depending on where the survey is conducted, these whales could be missed and go uncounted entirely. It is possible that in 2000/01 and 2001/02, a significant portion of the population did not migrate as far south as the census point. Unexpectedly low abundance estimates occurred in 1970/71, 1971/72, 1978/79 and 1992/93. However, in all but the first case, they were followed in subsequent seasons by much higher estimates (Rugh et al, in press). It is possible this was the case with the 2000/01 and 2001/02 surveys. It remains to be seen whether the point estimates from these years represent a slowing of the population growth or a stabilization at carrying capacity. However, based on the observed higher calf counts, lower strandings numbers and overall good physical appearance of whales during the southbound migration since the UME ended, there is no indication that the gray whale population is in decline.

This stock was previously listed as endangered but was removed from the list in 1994. In the northeastern Pacific, gray whales travel southward from summer feeding areas off Alaska and Canada to winter breeding and calving grounds in Mexico. This migration generally tracks the shoreline, within about 5 km of shore where the waters are typically less than 30 m deep (Wells et al., 1999). Pregnant females and cow-calf pairs are typically at the front of the migration, followed by non-pregnant females, males and juveniles. Some courtship and mating occurs along the migration path. At the end of the calving season, the northward migration is initiated by nonparturient adults (*i.e.*, males and females without calves) and juveniles, followed about a month later by cows and young of the year.

Prior to the mid-1970s, most calves were born in lagoons in Mexico. However, increased numbers of calves have been sighted by shore-based observers north of Mexico since 1980. Increased calf counts at sites north of Mexico have been correlated with warmer sea surface temperatures (D. Rugh, pers. comm.). It is thought that this trend is related to the increased abundance of the population, to changes in ocean climate, or both. A review of datasets maintained by the National Marine Mammal Laboratory and the American Cetacean Society suggest that nearly a quarter of the calving now occurs north of Carmel, CA (Sheldon et al, unpublished data). However, calves would still represent a small portion of the total number of gray whales migrating past or through the action area for the proposed study. It has been speculated that gray whales and some other baleen whales migrate to warmer waters to calve because the newborn calves, which have yet to acquire a sufficient layer of blubber, are more susceptible to heat loss. It should be noted that not all baleen whales migrate to give birth and small cetaceans, whose blubber layer is quite thin compared to the larger baleen whales, have successfully penetrated cold high-latitude waters. Bowhead whales live year-round in polar waters and give birth to calves there as well.

The stock structure of **blue whales** in the North Pacific is uncertain. For management purposes, NMFS has identified two stocks of blue whales in the North Pacific – the California/Mexico stock and the Hawaii stock. Although it was once thought that blue whales migrated from Baja, California to feed in the eastern Aleutians or Gulf of Alaska, no blue whale feeding aggregations have been found in Alaska despite several surveys (Caretta *et al*., 2002). One group of blue whales migrates from Mexico to feed in California waters from June to November. Blue whales are very common in southern California between June and September (Caretta *et al*., 2002). At the time of the proposed study, it is not likely any blue whales would be within the action area.

The current minimum population estimate for the California/Oregon/Washington stock of **fin whales** is 1,044 (NMFS 2001 Pacific Stock Assessment Report). In the North Pacific Ocean, fin whales can be found from above the Arctic Circle to lower latitudes of approximately 20^{o}N. There is little information on the wintering grounds of the Northeast Pacific stock of fin whales, because their migrations between summer feeding areas and winter grounds tend to occur in the open ocean where they are difficult to spot and track. There are no reliable estimates of the current abundance or population trends of this stock. Recent observations show aggregations of fin whales year-round in southern/central California, but the abundance is low. No fin whales were sighted during a study from 8-27 January 1998 conducted in the same location as the proposed study (Tyack and Clark, 1998).

There are no minimum population estimates for **sei whales** in the eastern North Pacific, nor is there data on trends in abundance (Caretta *et al*., 2002). The Eastern North Pacific stock of sei whales are distributed far out to sea in temperate regions. Sei whales are extremely rare in California waters and south and are therefore not likely to be affected by the proposed action.

In the Pacific, **minke whales** are typically seen over continental shelves and can be found year-round off California. There does not appear to be any seasonal pattern to their distribution. Other than the migrating gray whales, minke whales are the most likely baleen whale to be seen in the action area at the time of the proposed study. However, the estimated number of minke whales in California waters is approximately 201 (95% CI = 63-646).

Prior to being heavily exploited, the historical range of **right whales** in the North Pacific extended north of 35^{o}N and as far south as 20^{o}N across the Pacific Ocean (Caretta *et al*., 2002). Only 29 reliable sightings of northern right whales south of 50^{o}N have been reported in the eastern North Pacific between 1900 and 1994 (Scarff 1986, Scarff 1991, Carretta *et al.* 1994). Very little is known about the current North Pacific right whale population and it is not possible to reliably estimate minimum abundance. From 1958-1982 there were only 35 sightings of right whales throughout the central North Pacific and Bering Sea (Braham 1986). Right whales have been sighted in California waters in March through May. Given the low population abundance and previous sighting data, it is extremely unlikely that any northern right whales would be present in the action area at the time of the proposed study, thus they are not likely to be affected by the proposed action.

There appear to be four relatively separate migratory populations of **humpback whales** in the North Pacific. Whales from the Eastern North Pacific stock range from Costa Rica to Southern British Columbia but are most common in coastal waters off California (in summer and fall) and

Mexico (in winter/spring) (Caretta *et al*., 2002). Thus, at the time of year proposed for the study, it is not likely humpback whales would be present in the action area.

Beaked whales

Although **Cuvier's beaked whales** have been sighted along the U.S. west coast on several line transect surveys, sightings have generally been too rare to produce reliable population estimates. Cuvier's beaked whale is rarely observed at sea and is believed to be a deep-diving whale whose main prey items are squid and deepwater fish. Along the U.S. west coast, **Baird's beaked whales** have been seen primarily along the continental slope from late spring to early fall. During the colder water months of November through April, they have been seen less frequently and are presumed to be farther offhsore. (NMFS 2000 Pacific Stock Assessment Report) The minimum population estimate for the California/Oregon/Washington stock is 313. **Mesoplodont beaked whales** are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. The genus *Mesoplodon* includes many obscure and taxonomically confusing species about which very little is known. For this reason, and difficulty in identification to the species level even when a specimen is in hand, beaked whales are grouped together in the NMFS stock assessment reports. Five species of mesoplodont beaked whales have been recorded off the U.S. west coast: Blainville's (*Mesoplodon densirostris*), Hector's (*M. hectori*), Stejneger's (*M. stejnegeri*), Gingko-toothed (*M. gingkodens*) and Hubb's beaked whale (*M. carlhubbsi*). However, sighting are too rare to be able to determine possible seasonal or spatial patterns of distribution. Beaked whales in general are considered deep-divers and tend, therefore, to be pelagic in distribution. Within the action area of the proposed study the water is more shallow than that in which beaked whales are likely to occur. Thus, the chances of a beaked whale being exposed to the whale finder sonar systems are extremely rare.

Toothed whales

Sperm whales are found year-round in California waters, reaching peak abundance from April through mid-June and from the end of August through mid-November. As with the beaked whales, sperm whales tend to be found in deeper waters, usually beyond the 500 m isobatch. Within most of the action area of the proposed study, the 500 m isobath is greater than 9 miles offshore. The chances of a sperm whale being exposed to the whale finder sonar systems are extremely rare both because they are rare in California waters at that time of year and because they would likely be further off shore than the sounds would be audible.

In addition to the endangered sperm whales, a variety of smaller toothed whales are found in California waters. The species most likely to be present in the action area at the time of the proposed study are listed in Table 1 above. Small toothed whales are capable of hearing sounds in the frequency range of the proposed whale finder sonar systems. They are also capable of swimming rapidly away if they are disturbed by the sound. Several other species of toothed whales, such as dwarf and pygmy sperm whales, have been observed during stock abundance surveys; however, they are either distributed further offshore than the action area for the proposed action or are considered rare. Authorization for a permit is only requested for those species of toothed whales likely to be within the action area at the time of the study.

Pinnipeds

Unlike cetaceans who spend their entire lives at sea, pinnipeds divide their time between land and water. All species forage at sea, diving to various depths to capture their preferred prey. They give birth on land and their young stay onshore during the early portion of the lactation period. They also haul out on land to rest and to mate. California shores and waters are home to two species of true seals (phocids), two fur seals, and two sea lions (otariids). The timing of the proposed action does not coincide with the breeding season of any of these species. The species most likely to be present (at levels greater than a few individuals) in the action area at the time of the proposed study are harbor seals and California sea lions.

Harbor seals, which are true seals, are common inhabitants of coastal and estuarine waters across most of the U.S., including California. The pupping season for harbor seals in Central California begins in late March and peaks in May. Harbor seals are commonly known to be skittish on land, tending to flee into the water when disturbed. The other true seal species in California is the **Northern elephant seal**, which is the second largest pinniped in the world (second only to southern elephant seals, *Mirounga leonina*). Weaned pups leave rookeries at San Nicolas and San Miguel Islands (south of the action area) in late winter and spring. Most move northward to Año Nuevo and the Farallon Islands (north of the action area). Available data on elephant seal behavior at sea indicates that they tend to be deep divers that feed in deep waters of the continental slope. Outside of breeding season (which peaks in January) northern elephant seals range along the coasts of California, Oregon, Washington, and British Columbia.

The primary **northern fur seal** rookeries are in the Pribilof Islands. However, small numbers of northern fur seals breed and haul out seasonally in southern California (San Miguel and San Nicolas Islands) and on Southeast Farallon Island. Northern fur seals leave the Bering Sea in late November and migrate as far south as southern California. Most remain offshore along the continental shelf until March when they begin the northward migration back to their rookeries. Lactacting northern fur seals dive and feed most often at night. Pups are weaned in October and November and go to sea soon afterwards. **Guadulupe fur seals** only breed along the eastern coast of Guadalupe Island but individual fur seals have been seen further north, including the California Channel Islands. However, it is not likely Guadalupe fur seals will be within the action area at the time of the proposed study.

California sea lions of the CA/OR/WA stock breed in the Channel Islands in southern California, with the largest colony at San Miguel Island. A few pups are born further north at Año Nuevo and South Farallon. Breeding season is May through July. Lactacting females tend to forage within 100 km of their rookeries in southern California. The majority of **Steller sea lion** rookeries are found in Alaska. However, small rookeries and haul out sites do exist in California, Oregon, Washington and British Columbia waters. In California, Steller sea lions breed in small numbers at Año Nuevo, Southeast Farallon and Cape St. George Islands in the late spring/early summer. Given the relatively low abundance of Steller sea lions in California and the location of the rookeries, it is not likely that Steller sea lions will be present in the action area at the time of the proposed study.

Sea otters

The small group of southern **sea otters** left at Big Sur in 1911 has grown to a population of about 2500 that ranges along the central Californian coast from Pigeon Point near Santa Cruz in San Mateo County, south to Purisma Point north of Point Conception in Santa Barbara County. Although they have been observed to forage in depths up to 330 feet, sea otters tend to feed in waters less than 120 feet depth. In California, most births occur from late February to early April.

Marine mammal auditory capabilities

The hearing abilities of a limited number of toothed whales (odontocetes), seals, and sea lions have been studied in some detail. Hearing abilities of baleen whales and sea otters have not been studied directly, but some inferences have been made. **Toothed whales** are most sensitive to sounds above 10 kHz, but their upper limits of hearing range from 65 kHz to well above 100 kHz (Richardson *et al*., 1995). Both bottlenose dolphins and belugas can hear sounds at frequencies as low as 40-125 Hz, but their sensitivity deteriorates with decreasing frequency below about 10 kHz. Within the range of "middle" frequencies where toothed whales have their best sensitivity, their hearing is very acute. Their sensitivity also decreases as the duration of the signal decreases below 0.1 to 0.2 seconds, although they appear to have specialized mechanisms for processing sequences of short pulses, as with their echolocation sounds (Richardson *et al*., 1995). Masking of sound signals by background noise has only been studied in bottlenose dolphins, beluga, and killer whales. Results of these studies indicate that some toothed whales can detect sounds weaker than the total background noise in the masking band. Toothed whales, and probably other marine mammals, have capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. Observations of toothed whales shifting the dominant frequency of their echolocation signals toward frequencies with less background noise and increases in source levels of echolocation signals to circumvent noise demonstrate adaptations for reduced masking of the very high frequency echolocation signals of toothed whales (Richardson *et al*., 1995).

Indirect indications are that **baleen whales** are most sensitive to low-frequency sounds. However, there is evidence that gray whales can detect higher frequency killer whales sounds whose received levels are about equal to the broadband noise level and humpback whales reacted to sonar signals at 3.1-3.6 kHz (Richardson *et al*., 1995). Baleen whales were observed to react to sounds at frequencies up to 28 kHz, but did not respond to pingers and sonars at 36 kHz and above (Richardson *et al*., 1995). Indirect evidence suggests that baleen whales are most sensitive to frequencies below 1 kHz, but some can hear sounds up to much higher frequencies. If baleen whales have thresholds similar to other marine mammals, which range between 40 and 70 dB re 1μPa at the frequencies to which they are most sensitive, then baleen whales' ability to detect sounds is most likely limited by oceanic ambient noise (Richardson et al. 1995). Average ambient noise levels in the ocean are above 75 dB re 1μPa in all 1/3-octave bands below 1 kHz, even in quiet conditions (sea state 1) and without nearby industrial activities.

As mentioned above, some gray whale calves may be born before their mothers arrive at the calving grounds in Mexico. Newborn or very young calves may have better hearing sensitivity at very high sound frequencies than adult whales, based on observations in terrestrial mammals. However, in other mammals, neonatal hearing abilities at the extreme upper detectable frequencies deteriorates rapidly due to natural processes. This trend almost certainly applies to gray whales as well. Regardless of the upper limits of gray whale calf hearing range, the sounds produced by the whale finder sonar would not likely interfere with any communication between mother and calf since adult gray whales do not produce high frequency vocalizations that could be masked by the sonar, nor are the adults likely to be very sensitive to high frequency sounds (meaning the calves probably would not use high frequencies to communicate with their mothers).

Masking (see Appendix B) of gray whale or other marine mammal communication during the proposed study is unlikely for a number of reasons. First, the duration of the sonar signal is less than a second, which is shorter than the duration of marine mammal vocalizations so masking is not likely even if there were frequency overlap between the sonar and the marine mammal vocalization. Second, adult gray whales, like other baleen whales, vocalize and are predicted to hear best at frequencies well below the frequency range of the whale-finder sonars. As a sound deviates further and further from an animal's "best frequency" (see Appendix B) it needs to be increasingly louder to be audible. Thus, most if not all of the sound from the whale-finder sonars would be inaudible to gray whales. This would also apply to other high-frequency sounds at or near the predicted limits of hearing sensitivity of gray whales. It is therefore not logical to assume that gray whale calves would use high-frequency vocalizations at or above 20 kHz to communicate with their mothers.

There is no indication that gray whale calves use frequencies at or above 20 kHz for their vocalizations. According to Dr. Tyack[9], a recognized expert in the field of marine mammal acoustics: "The sounds of gray whales on the migration have been extensively studied and no reports of sounds from migrating gray whales indicate energy at frequencies this high. All other reports document whale calls from several hundred to several thousand Hz." Table 7.1 in Richardson et al (1995) makes [reference] to clicks of gray whale calves having energy from 100 Hz to 20 kHz. Dr. Tyack further points out that :

> "One of the two references for this entry (Fish e*t al*. 1974) summarizes data on gray whale sounds, emphasizing frequencies below 3 kHz. It then mentions recordings of clicks with peak energy well below 1 kHz, but with detectable energy up to 10 kHz. The other [reference] is Norris et al. (1977), a paper on the behavior of gray whales in southern Baja. Norris and co-workers put a noose around gray whale calves, pulled them onto the shore, and attached harnesses with radio tags, before releasing the calf to the waiting mother. While two of the calves were involuntarily stranded half out of the water, they made very intense broadband clicks. All broadband clicks have high frequency energy. The 20 kHz limit reported by Norris et al for the intense clicks of gray whale calves stems from the bandwidth of the recording system, not from the click itself: "a very intense broadband signal is portrayed, perhaps of frequency range extending well above the flat response band of our instrumental system (0.1-20 kHz)." The existence of high frequency energy in a broadband click is a consequence of the rapid rise of the click; in this case it may also be an artifact of overloading. The overwhelming predominance of energy in the click lies below 10 kHz and there no suggestion was made that the high frequency element of the signal was important for communication."

9 Dr. Peter Tyack, pers. comm.., December 12, 2003

The upper limit of effective hearing in **seals** is approximately 60 kHz, although some species of seals can apparently detect very high frequency sounds (up to 180 kHz) underwater (Richardson *et al*., 1995). Their sensitivity to frequencies at or below 100 Hz is better than in toothed whales or sea lions, but their frequency discrimination and ability to process click sequences are less precise than that of toothed whales. **Sea lions** have hearing sensitivity similar to seals at moderate frequencies, but their upper limit is lower – 36-40 kHz (Richardson *et al*., 1995). No audiograms are available for **sea otters**. However, measures of hearing in air for two North American river otters indicate a functional hearing range of 0.45 to 35 kHz in air (Wartzok and Ketten 1999). In addition, sea otter vocalizations are similar in frequency to those of pinnipeds and terrestrial carnivores. It is reasonable to assume that sea otters may be able to detect the sound of the whale finder sonar as well as the pinniped species. Note that no physical injury or even temporary threshold shift in those species capable of hearing the high-frequency whale-finder sonars is likely from the proposed study because of the brief signal, limited duration of the study, and received energy level of the sounds.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter represents the scientific and analytic basis for comparison of the direct, indirect, and cumulative effects of the alternatives. Regulations for implementing the provisions of NEPA require consideration of both the context and intensity of a proposed action (40 CFR Parts 1500-1508). Thus, the significance must be analyzed in several contexts, such as society as a whole, the affected resources and regions, and the affected interests. Intensity refers to the severity of the impact and the following 10 specific aspects that must be considered: (1) beneficial and adverse effects; (2) effects on public health and safety; (3) unique characteristics of the geographic area (*e.g.*, proximity to historic or cultural resources, park lands, and ecologically critical areas); (4) degree to which possible effects are likely to be highly controversial; (5) degree to which possible effects are highly uncertain or involve unique or unknown risks; (6) precedent-setting actions; (7) whether the action is related to other actions with individually insignificant but cumulatively significant impacts; (8) loss or destruction of significant scientific, cultural, or historical resources (including adverse effects on sites listed in the National Register of Historic Places); (9) degree to which action may adversely affect an endangered or threatened species or designated critical habitats; and (10) violation of Federal, state, or local laws imposed for protection of the environment.

NMFS has, through NAO 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by the Council on Environmental Quality. NAO 216-6 specifies that issuance of scientific research permits under the MMPA and ESA is among a category of actions that are generally exempted (categorically excluded) from further environmental review, except under extraordinary circumstances. Specifically, when a proposed action that would otherwise be categorically excluded is the subject of public controversy based on potential environmental consequences, has uncertain environmental impacts or unknown risks, establishes a precedent or decision in principle about future proposals, may result in cumulatively significant impacts, or may have an adverse effect upon endangered or threatened species or their habitats, preparation of an EA or EIS is required.

Issuance of a scientific research permit under the MMPA and ESA authorizes "takes" of marine mammals and threatened or endangered species, respectively. Given the definitions of take, harassment, and harm under the MMPA and ESA (see footnotes number 1 and 2), a "take" as authorized under a permit issued pursuant to the MMPA or ESA could be considered an "adverse effect" on the affected individual animal under NAO 216-6.

In the case of the proposed action, the most likely avenue for "take" is via "Level B" harassment related to short-term disruption of behavioral patterns. Since the proposed action would occur within the range of various marine mammal species, some individual marine mammals may be "taken" through harassment. However, it should be noted that an adverse effect upon an individual animal does not necessarily equate to an adverse effect upon the entire species to which that animal belongs. Since NEPA does not define what an adverse effect on a threatened or endangered species is, NMFS will rely upon the following to examine the degree to which a proposed action will result in adverse effects on a listed species.

An adverse effect on an individual marine mammal does not necessarily translate into an adverse effect on the population or the environment. In order for an adverse effect on an individual member or some number of individuals of a species to result in an adverse effect on the species as a whole, the effects on the individuals must result in reduced reproduction or survival of the individual that would consequently result in an appreciable reduction in the likelihood of survival or recovery for the species. Therefore, in order for the proposed action to have an adverse effect on a species, the exposure of individual animals of a given species to the whale-finder sonar systems would first have to result in direct mortality or serious injury that would result in mortality of the exposed individual, or disrupt essential behaviors of the exposed individual, such as feeding, mating, or nursing, to a degree that the individual's likelihood of successful reproduction or survival was substantially reduced. Second, that mortality of an individual or substantial reduction in the individual's likelihood of successful reproduction or survival would have to result in a net reduction in the number of individuals of its species. In other words, the loss of the individual or its future offspring would not be offset by the addition, through birth or emigration, of other individuals into the population. Third, that net loss to the species would have to be reasonably expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild. The effects of the proposed action on threatened and endangered species are further evaluated through the interagency consultation process pursuant to Section 7 of the ESA, as described in Section 4.4 below.

Whether or not a marine organism may be affected by the proposed action is dependent on two factors. The first factor is whether or not the organism is likely to be present within the action area at the time of the research. Some marine organisms, such as the migrating gray whales, are only in the action area at certain times of year, others may only be present at certain times of day. The second factor is whether or not the organism can detect (hear) the sounds produced by the whale finder sonar systems. Whether or not an organism can detect the sound is dependent on its auditory threshold at a given frequency. Auditory threshold is the audibility limit of discriminating sound intensity and pitch. In other words, auditory threshold is a measurement of the weakest sound of a given frequency that an individual can detect. As an example, humans are capable of hearing 32 kHz sounds, but only when they are extraordinarily loud because our ears are not as sensitive at detecting sounds in this frequency range compared to lower frequencies.

For those organisms that are present and can detect the sounds, whether or not they will be adversely affected is a function of their exposure as well as their response. Exposure is a function of the frequency and energy level of the source (which determine how far the sound will travel and how "loud" it will be at a given distance), proximity to the source (which also determines "loudness"), and duration of the sound over a given time interval. For a given organism, response is likely to be a function of a variety of biological factors. For example, whether or not a dolphin that hears the sound deviates from its course or otherwise alters its behavior could depend on its age, sex, reproductive condition, the time of year or day, the behavior of other dolphins in its vicinity, the specific behavior in which it was engaged at the time of exposure, or some combination of the above.

At any given distance from the source, only those marine organisms with hearing sensitivity at the received sound level and in the frequency range of the whale finder sonar systems will be “exposed” during the proposed research. Available information on the hearing sensitivity of invertebrates, sea turtles, sea birds, and most fish (as summarized in Chapter 3) suggests they are not likely to be “exposed” at any time during the proposed action. For the pinniped and odontocete species within the action area, “exposure” is likely up to 15 – 33 km (or appx. 10 – 20 miles) from the source. It is not certain, but probable that gray whales and other baleen whales would not be able to detect the sounds. Nevertheless, a conservative estimate is that they could be exposed at similar distances from the source as toothed whales.

A previous permit issued by NMFS authorizing use of a whale-finder sonar system was permanently enjoined by a Federal court prior to initiation of any research activities (Hawaii County Green Party vs. Evans, C-03-0078-SC, U.S. District Court, Northern District of California). The court found that, in contradiction to agency guidance provided in NAO 216-6, NMFS incorrectly invoked a categorical exclusion in issuing the permit. As discussed in Section 1.2 above, NMFS has previously prepared EAs on active acoustics research permits because of “public controversy” (*i.e*., first Tyack EA; NMFS 2000) or uncertain environmental impacts (*i.e*., second Tyack EA; NMFS 2003). While virtually any activity involving acoustics and marine mammals has been perceived by some members of the public as “controversial,” there is no scientific evidence to indicate that the whale-finder sonar systems in the proposed action could have a significant adverse impact on the human environment, including marine mammals or threatened and endangered species. There is no evidence of injury to marine mammals associated with the use of low power, high frequency sonars of the type in the proposed action. If such sonars (including fish finders and depth sounders) were capable of producing injury, their ubiquitous use over several decades would have resulted in hundreds of thousands of injured marine mammals by now.

Although a secondary purpose of the proposed action is to observe any reactions of the target species to the whale finder sounds, there is no scientific uncertainty about whether the whale finder sonar systems will cause physical injury: not only does it operate mostly above the gray whale’s hearing range, but the level and duration of the signal at the source are insufficient to cause such injury to any marine organism. Further, because the frequency range of the whale finder sonar makes it largely if not entirely inaudible to gray whales, avoidance/disturbance reactions from gray whales are unlikely. The only effect anticipated from exposure to the whale finder sonar is short-term disturbance/avoidance behaviors by some small cetaceans and possibly some pinnipeds or sea otters very near the source. Thus, there is not a substantial degree of uncertainty about the potential impacts on the human environment.

It is likely that, following the validation studies in the proposed action, others will adopt Dr. Stein’s whale-finder sonar systems for their operations. The whale finder sonar systems developed by Dr. Stein are analogous in purpose (detection of objects underwater), frequency range, source level, and power output to the low-power depth sounders and fish finders already found on hundreds of thousands of vessels operating in the ocean. As discussed in Section 2.2, the primary difference between the whale-finder sonars and fish-finders/depth-sounders is in the sophistication of the signal processing. Thus, issuance of the research permit as described in the proposed action would not establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration. On the contrary, if the results of the proposed action result in improvements to the accuracy of the whale finder sonar systems, beneficial environmental impacts can be expected as the system is put to use protecting marine mammals from potentially harmful human activities such as explosions, airgun arrays, or high-powered sonars.

4.1 Effects of Alternative 1 – No Action

Most data on effects of noise on cetaceans arises from research on a limited number of toothed whale and pinniped species. It is therefore necessary to extrapolate from these species to less studied species such as deep diving sperm and beaked whales. However, the suggested correlation between mass strandings of beaked whales and operations of high power sonars (Simmonds and Lopez-Jurado 1992; Frantzis 1996), the observed variability of sperm whale behavior in response to sound (Madsen *et al*., 2002, Watkins and Schevill 1975; Watkins *et al*., 1985), and possible whale avoidance of loud seismic vessels at great ranges (Bowles *et al*., 1994; Mate *et al*., 1994) suggest that more data are needed, especially specific to these deep diving species. As long as powerful sound sources are operated in the ocean, marine mammals will be exposed. The No Action Alternative would prevent the acquisition of information critical for protecting marine mammals from the potential adverse effects of high power sound sources.

As discussed in Section 2.1, factors such as vessel interactions, other research activities directed at marine mammals, habitat degradation (pollution) and anthropogenic noise from airplanes, helicopters, recreational boating and commercial shipping would continue to have an impact under the No Action Alternative. The existing baseline condition is that the ocean in general is a very noisy place, particularly developed coastal regions like that of the action area. Although there would not be the contribution of up to an additional 12 hours per year of sound from another low-power high-frequency sonar in the action area, the absence of this sound (as with its presence) would likely go unnoticed because of ambient noise, including all the fish-finders and depth-sounders being operated by recreational and commercial vessels.

4.2 Effects of Alternative 2 – Proposed Action

Richardson *et al*. (1995) establish four criteria for defining the potential effects of anthropogenic sound on marine mammals. The first is the “zone of audibility” or the area in which the marine mammal might hear the noise. The second is the “zone of responsiveness,” which is the region within which the animal reacts behaviorally or physiologically. The third is the “zone of masking,” or the region within which noise is strong enough to interfere with detection of other sounds. The fourth is the “zone of hearing loss, discomfort, or injury” where the received level is high enough to cause discomfort or damage to auditory or other tissues. For the purpose of evaluating the potential impacts of the whale finder sonar systems on marine mammals, the zones of responsiveness and masking could both be considered areas where “level B” harassment could occur and the zone of hearing loss, discomfort, or injury is the area where “level A” harassment could occur.

For a given species, the zone of audibility for a specific sound is a function of the animal’s optimum frequency range, its absolute hearing threshold, and ambient noise. Thus, there are at least three mechanisms that determine whether a marine animal could be affected or conversely, would not hear the whale finder sonar. First, if the animal cannot hear sounds at or above 20 kHz, it will not be within the zone of audibility regardless of how loud the sound is. Second, if the animal can hear sounds at or above 20 kHz, but only when they are above a certain level, such as 80 dB, then only those animals closest to the sonar will be within the zone of audibility. Last, if the animal can hear sounds at or above 20 kHz and is within a distance where the sound level is above its detection threshold for sounds of that frequency but the ambient noise level is greater than the received level of the sonar, the animal is not within the zone of audibility. Based on the information available on hearing ability of a variety of marine organisms, only marine mammals are likely to be within the zone of audibility of the whale finder sonar. Therefore, the remainder of this section will focus on potential impacts to marine mammals; fish, sea turtles, invertebrates and seabirds will be excluded from further consideration.

For those marine mammals within the zone of audibility, or the action area as described in Chapter 3, whether or not they have an observable response is a function of numerous biological factors. The activity, habitat, age and sex class of an individual at the time of exposure to the sound influence their response. For example, bottlenose dolphins appeared least responsive to the approach of a small boat when they were socializing (Richardson *et al*., 1995). Whether or not animals are habituated or sensitized to a particular sound will also affect their response. Animals that have learned to associate a particular sound with severe harassment may be more responsive to that sound than to sounds they do not associate with a threat.

Some behavioral indicators of disturbance, or “level B” harassment, are avoidance (moving away from the sound), increased vigilance, cessation of an activity, or changes in swim speed or surfacing interval. Avoidance reactions are the most obvious indicators of disturbance. Avoidance reactions can be strong or mild and can have varying effects on individuals. Migrating gray whales were observed to alter their course by 30^{o} as they approached an industrial sound source, which allowed them to pass well to the side of the source without making a large change in their course or the length of their migration (Richardson *et al*., 1995). In addition to avoidance reactions, marine mammals may respond to underwater sounds by changing their activity. For example, cetaceans that are resting or socializing at the surface may dive or start to travel slowly at the onset of man-made noise. The most likely effect of the whale finder sonar sounds on marine mammals is avoidance. Because the zone of audibility would be so small, a marine mammal would only have to move a short distance (a few meters in most cases) to be outside the area of exposure. Given the small spatial extent of the zone of audibility for toothed whales, pinnipeds and sea otters, and the brief duration of the proposed study, any avoidance or other behaviors indicative of disturbance are likely to be mild and short-lived with little potential for adverse impacts on the survival or reproductive success of individual marine mammals or marine mammal species. Even short-term behavioral responses are unlikely given the similarity of the sounds of the whale-finder sonars to existing noise from fish-finders and depth-sounders. In other words, from a marine mammal’s perspective, a ping from the whale-finder sonar may sound no different from all the other low-power high-frequency sonar pings already in its environment.

Given that most ship noise is low frequency, gray whale vocalizations are low frequency, and gray whale hearing is best at low frequencies, if any anthropogenic sounds were going to interfere with migration or mask communication between cows and calves, it would likely be vessel noise. Throughout the course of their migration gray whales are exposed to anthropogenic sounds, including passing by six major shipping ports between Alaska and Mexico. Exposure to anthropogenic sound has clearly not been a deterrent to gray whale migration. In the unlikely event that migrating gray whales could hear the whale finder sonar, they would only have to make very minor changes in their course to avoid the sound. Such a minor course adjustment would not likely have a measurable effect on the duration of their migration.

At this point, it is important to note that whales may react to the presence of the research vessel even when the whale finder sonar is not in operation. They may or may not alter their course to avoid the vessel. Thus, even when the sonar is in operation, at least some avoidance/disturbance responses may be due to the physical presence of the research vessel in the migratory path rather than to the sound of the whale finder sonar. In fact, because most of the sound produced by the whale finder sonar would be well above the predicted hearing range of gray whales, it is more likely that any observed changes in behavior would be due to the presence of the vessel rather than the sonar. In that respect, the effects of the Proposed Action are essentially no different than the baseline condition in which whales may routinely avoid (or ignore) the presence of vessels in the water.

Some communication calls and other natural sounds important to marine mammals can be masked by anthropogenic sounds, including sonar. However, in the gray and other baleen whales, masking is most likely to result from lower frequency sounds such as vessel noises. Because of the high frequency of the whale finder sonar systems' signal, there is a potential for masking the high frequency echolocation signals of some toothed whales in the action area. However, the very short duration of the sonar pings, combined with the brief duty cycle make such masking improbable. In addition, studies suggest that many toothed whales are capable of modifying both the frequency and source level of their echolocation pulses so that they can be detected over ambient noise. Regardless of whether or not masking is likely for a given species, the effect would be very short term due to the nature of the study. The whale finder sonar systems would not be producing a constant sound; the pulse length would be less than 1 second and the duty cycle would be less than 10%. In addition, the zone of audibility would be so small that any marine mammal whose communication or other sounds were being masked could quickly move out of range of the sound.

Exposure to high energy sound (where energy is a combination of received level and the sound duration) can cause physiological damage. For example, the blast exposure thought to be safe for protecting humans underwater from injury to the digestive tract is pulses of 10 psi-msec and peak pressures of 237 dB re 1 μPa (Gaspin 1983). ONR (1999:65) cites (Turpenny *et al.*, 1994) stating that the lack of gas-filled cavities in most invertebrates and fish without swimbladders make the risk of injury low at exposure levels <217 dB re 1 μPa. Swimbladder fish and marine animals with lungs are thus among the marine organisms most sensitive to intense pulses of sound energy. Blast-induced pressure waves may kill swimbladder fish at ranges of up to several km. Very little has been published about these non-auditory blast effects on marine mammals. Hemorrhage in the lungs and contusion and ulceration of the gastro-intestinal tract were detected in experiments where submerged terrestrial mammals were exposed to underwater explosions at close range. These effects occur at lower exposure factors for smaller animals than for larger ones. The sounds from the whale-finder sonars would not contain enough energy to result in tissue damage or other injury.

Exposure to some man-made noises has been associated with auditory damage in some marine mammals. For example, damage to the inner ear was observed in Weddell seals, *Leptonychotes weddellii,* collected from McMurdo Sound, Antarctica shortly after a series of dynamite explosions. The locations of these seals during the explosions and their exposure levels were unknown. Of ten cochleas that could be examined, five were found to be damaged. Degeneration of the organ of Corti and corresponding damage to the eighth cranial nerve were observed (Bohne *et al*., 1985, 1986). Blast damage to the auditory system of humpback whales has also been documented by Ketten *et al*. (1993). These whales were in the vicinity of underwater blasts from 5000 kg of high explosive, but their exposure level and duration were unknown. However, the whale finder sonar systems do not produce the kind of impulse waveform associated with blast damage, nor is the sound level of the sonar intense enough or of long enough duration to likely cause non-auditory damage. Therefore, within the zone of hearing loss, discomfort, or injury, only the potential for hearing loss and discomfort will be considered further.

There are no audiograms (*i.e.,* direct measurements of the auditory thresholds) for baleen whales, nor are there data on what sound exposure may cause Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) in baleen whales. (See Appendix B for an explanation of these and several other acoustic terms that may facilitate understanding of the discussion.) It is therefore necessary to extrapolate from data from other animals, and to make assumptions about hearing. The following assumptions are used in deriving a threshold for potential auditory effects:

- TTS and PTS in marine mammals occur at intensity-duration limits similar to those in land mammals
- Immediate PTS can be caused by exposure to sounds 155 dB over threshold
- TTS to a signal >80 dB over threshold requires prolonged exposure (8 hours/day)
- Risk of TTS decreases with shorter exposures. Human criteria: 82 dB for 2 hours/day; 88 dB for 30 min/day; 98 dB for 7 min/day; 115 dB for 1.5 min/day. All dB values above threshold.
- The critical band of hearing is about 1/3 octave

The best hearing for toothed whales in which hearing has been tested is about 40 dB re 1 μPa. This is typically at frequencies > 10kHz, where the ambient noise at Beaufort Sea State 0 has an average third octave band level of about 60 dB re 1 μPa. Ambient noise levels are higher at lower frequencies. Even if baleen whales are adapted for lower frequency hearing, their hearing may have evolved to have a similar sensitivity with respect to the ambient noise. The third octave level for 1 kHz at Beaufort Sea State 0 is about 70 dB re 1 μPa. Ketten (1998) suggests that the sensitivity of baleen whales at low frequency is unlikely to be lower than 80 dB re 1 μPa.

Assuming the above assumptions are either correct or conservative, then baleen whales might experience PTS after exposure to sounds 80+155 = 235 dB or more re 1 μPa. There might be some risk of TTS from very prolonged exposure of animals to received levels of sounds at > 160 dB re 1 μPa. In the proposed experiments, it is very unlikely that any baleen whale would be exposed to received levels > 160 dB for more than a few pings on one day. Since gray whales and other baleen whales are not expected to be able to hear most of the high frequency whale finder sonar sounds, they may not be "exposed" at all, regardless of their proximity to the source or amount of time spent in the action area. For the toothed whales, pinnipeds and sea otters that may be exposed, the maximum duration of exposure would not exceed eight hours in a day (or 120 hours over the course of the study) because the sonar would only be operated during daylight hours. Recall also that, with a 10% duty cycle, this actually means less than one hour per day or 12 hours over three-four weeks per year of actual sound. NMFS believes that it is unlikely that any of the marine mammals would experience significant effects, based on the fact that their exposure to the sounds used in these experiments would be brief. In the case of the migrating gray whales, individual animals are not likely to be within the action area for more than one 8 hour period. This assumes they take a path directly through the widest part of the action area (which would be as much as 40 miles depending on frequency, ambient noise levels, etc.), entered the action area at the beginning of the study that day, and swam at a speed of 5 knots (5.75 miles/hour) or less the entire time (*i.e.*, 5.75 miles/hour over 40 miles = 7 hours). Eight hours is a very small fraction of the total time it takes for a gray whale to conduct its southbound migration of more than 8,000 km (appx. 4, 972 miles).[10]

Baleen whales are not likely to experience TTS from the proposed activities because received levels will be too low to cause immediate TTS and the durations of the exposure periods are too short to yield prolonged exposure TTS. Masking effects should be minimal due to the short transmission period of the sounds.

Ridgway *et al*. (1997) tested bottlenose dolphins to see what exposure factors could cause temporary threshold shifts for one second signals. Frequencies of 3, 20 and 75 kHz yielded masked TTS at exposures (received levels) ranging from 192-201 dB re 1 μPa (*i.e.*, 115-150 dB above hearing threshold). The short duration of the sound transmissions in the proposed study, as well as the high levels required to achieve TTS in odontocetes suggest that the proposed whale finder sonar study would have only minimal impact on toothed whales and dolphins.

4.3 Comparison of Alternatives

The annual operation of the whale-finding sonar in the proposed research will involve a maximum of 120 hours per year of the permit, spread over a three to four week period in a given year, with a 10% duty cycle for approximately 12 hours of actual sonar sounds. Compared to the baseline noise level of the No Action alternative, this does not represent a substantial increase in exposure to noise by any marine mammals in the action area. At the level of individual toothed whales, pinnipeds and sea otters, who would only be exposed to the sound for a minute fraction of the total operation time, the Proposed Action may result in a very small amount of additional disturbance as they pass within the zone of responsiveness as discussed above. However, the duration of any exposure would be brief and behavioral responses to detection of the sonar sounds would be short lived. In fact, compared to the baseline condition in which countless high-frequency fish-finders and depth-sounders are in operation, the sounds from the whale-finder sonars under the Proposed Action may not result in any more effect on those marine mammals that can hear high frequency sounds than under the No Action Alternative. In the case

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10 At 5.75 miles per hour, it would take a gray whale approximately 865 hours to travel the roughly 4, 972 miles between its northern feeding grounds and the southern calving lagoons.

of the target species, gray whales, no additional effects of the Proposed Action are anticipated compared to the No Action alternative because it is unlikely they will be able to detect the sonar sounds. The same is true of other baleen whales. The potential for adverse impacts on the human environment is not greater under the Proposed Action compared to the No Action alternative.

4.4 Compliance With ESA

This section summarizes conclusions resulting from consultation as required under section 7 of the ESA. The consultation process was concluded after close of the comment period on the application and draft EA to ensure that no relevant issues or information were overlooked during the initial scoping process summarized in Chapter 1. For the purpose of the consultation, the draft EA represented NMFS' assessment of the potential biological impacts.

NMFS determined that southern sea otters would be present in the action area and may be affected but were not likely to be adversely affected by the proposed study. Although sea otters can probably hear in the frequencies at which the whale-finder sonars would operate, their exposure to the sounds would be limited because of the short duration of the sounds and brief duty cycle. In addition, sea otters do not spend 100% of their time underwater, which would further limit their exposure to the sounds. In addition, the whale-finder sounds are not capable of causing injury or temporary threshold shift. Finally, the whale-finder sonar sounds are so similar to the ubiquitous fish-finders and depth-sounders already in the sea otters' acoustic environment, it is likely that the effect of the sounds from proposed study on sea otters would be negligible compared to existing conditions. On December 15, 2003 the USFWS concurred with NMFS determination that issuance of the requested permit is not likely to adversely affect the southern sea otter.

NMFS also determined that threatened Steller sea lions, threatened Guadalupe fur seals, and endangered blue, fin, humpback, right, sei, and sperm whales were not likely to be adversely affected by issuance of the proposed permit. Steller sea lions and Guadalupe fur seals can probably hear high-frequency sounds in the range of the whale-finder sonars. However, they are not likely to be present in the action area at the time of the proposed study. Blue, humpback, right, and sei whales are also not likely to be present in the action area at the time of the proposed study, nor are they likely to be able to hear the high-frequency sounds of the whale finder sonar. The seasonal distribution of fin whales and sperm whales is somewhat less predictable than that of the other large whales but the probability of their occurrence in the action area at the time of the proposed study is too low to predict. Like the other baleen whales, fin whales are also not likely to be able to hear the high-frequency whale-finder sounds. Sperm whales are likely to be able to hear in the frequency range of the whale-finder sonars, but, in addition to not being likely to be present, the whale-finder sonar sounds are so similar to the ubiquitous fish-finders and depth-sounders already in their acoustic environment, it is likely that the effect of the sounds from proposed study on sperm whales would be negligible compared to existing conditions. This is true for all the marine mammal species that may be present in the action area.

4.5 Mitigation Measures

A number of measures are built into the proposed study that are intended to minimize the potential for adverse effects on marine mammals. As mentioned in Section 2.2 above, the system would be operated using a ramp-up procedure when first turned on so that the source level starts no higher than 180 dB re 1µPa at 1 m and increases no faster than 5 dB per minute. This would allow any marine animals in the action area that can detect the sound to, if they choose, move away before the sound reaches the maximum source level. Further, the source level would drop to 180 dB re 1µPa at 1 m if an object with a target strength (*i.e.*, detection by the sonar) greater than –20 dB re 1 m is detected inside of 100 m from the source. The maximum source level was chosen, in part, to ensure that received levels would drop to 180 dB re 1µPa within 100 m of the source. There would also be observers on board the research vessel and on shore who would be able to detect marine mammals that may come close to the source and who would have the sonar shut down if any were within 100 m. In the case of endangered species, although none are likely to be present, the source would be shut down if any were detected within 2 km. The test would only be conducted in daylight hours to ensure adequate visual monitoring. All of these measures are designed to ensure that the sonar would not operate at full power or would be shut down if a marine mammal were detected within 100 m. NMFS wishes to reiterate that all the above mitigation measures are extremely conservative given that available information does not indicate a potential for injury from the whale finder sonar systems as described in the proposed action. These mitigation measured would also minimize the potential for "level B" harassment.

Additional mitigation measures to minimize the potential impacts of level B harassment would also be included. Although it is not likely that gray whales – nursing, pregnant, nursing, or otherwise – would be affected, the permit would require that the sonar be turned off immediately if there is any evidence that the activity may be interfering with pair-bonding or nursing. The permit would require that research activities directed at an animal be discontinued if it exhibits behaviors indicating a strong reaction to the whale-finder sonars, either during or immediately after exposure to the sounds.

As discussed in Section 3.3.5, migrating gray whales tend to be segregated in time by age, sex, and reproductive condition, starting with pregnant females. Thus, at the peak of the migration, when the study is proposed, it is likely that the majority of gray whales ensonified will be non-pregnant females, males and juveniles. Although the Proposed Action would not have a disproportionate effect on pregnant animals or unborn calves relative to non-pregnant animals or males, the timing of the study minimizes the likelihood that pregnant females would be ensonified.

Mitigation measures are in place to prevent exposure of human divers that may be within the study area to sounds that could cause TTS or injury. The high-frequency sounds would diminish in energy to 160 dB re 1µPa within 1 km from the source. This is within safe exposure levels for human divers (E. Cudahy[11], pers. comm.). In addition, the observers would be able to spot any dive vessels within 1 km and turn off the sonar to avoid the chance of exposing divers to received levels higher than 160 dB.

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11 Dr. Cudahy is Dept. Head of the Diving and Environmental Simulation department of the Naval Submarine Medical Research Laboratory in Connecticut.

4.6 Unavoidable Adverse Effects

The mitigation measures imposed by permit conditions are intended to reduce, to the maximum extent practical, the potential for adverse effects of the research on the targeted species as well as any other species that may be incidentally harassed. However, as discussed above, the sound of the whale finder sonar may cause disturbance to some marine mammals in the zone of audibility and may temporarily interrupt normal activities such as feeding and mating. The effect on the animals is not expected to exceed "level B" harassment, as defined under the MMPA, or to have a significant long-term effect on individuals or the population. In other words, while individual marine mammals may exhibit temporary disturbance or evasive behaviors in response to the activities of researchers, the impact to individual animals is not likely to be significant because the reactions will be short-lived. Further, reactions to the sonar sounds are not anticipated because the short signal duration and brief duty cycle mean that exposure would be extremely limited and probably indistinguishable from the existing baseline conditions in which countless other high-frequency sonars (fish-finders and depth-sounders) are already in operation.

4.7 Cumulative Effects

4.7.1 Intentional lethal takes

Most species of baleen whales were the targets of commercial whaling. Commercial whaling is the reason most species of large whale were listed as endangered under the ESA. Only a small number of nations currently engage in commercial whaling of a few species of baleen whales. The most common targets of modern whalers are the minke whale and sperm whale. A limited number of gray whales are still harvested for subsistence purposes in Washington and Alaska. Many pinniped species, including northern fur seals and Galapagos fur seals, were harvested for their fur, resulting in substantial reductions in population abundance. However, such harvests have been prohibited in the U.S. since the enactment of the MMPA in 1972. A limited number of pinnipeds are still harvested for subsistence purposes in Alaska, however, none of these animals would be from the stocks considered in the proposed action. Shooting of small cetaceans and pinnipeds that were thought to be interfering with commercial fishing operations has occurred, but it is currently prohibited under the MMPA. Since the take prohibitions of the MMPA and ESA became effective, marine mammals in the U.S. have been protected from intentional lethal take with the exception of subsistence harvests of a few species in Washington and Alaska. Although harvests may have contributed to previous declines of some species of marine mammal in California waters, intentional lethal takes are not currently considered to be a factor affecting any of the stocks in the proposed action.

4.7.2 Entrapment and entanglement in fishing gear

For most marine mammal species listed in Table 1 above, incidental capture in fishing gear is not an issue of concern relative to their population abundance and productivity rates. Estimates of annual fishing-related mortality are well below Potential Biological Removal limits established for most stocks. With the exception of humpback whales, annual fishery-related mortality for the endangered species is zero. Actual numbers of observed and estimated fishery-related mortality by stock are provided for each species in the annual stock assessment reports, which are available from the NMFS website. Given the low numbers of interactions for most stocks, and that the effects of the proposed action would be limited to short term "level B" harassment, the proposed action is not likely to result in cumulative impacts in combination with interactions with fisheries.

4.7.3 Vessel interactions

Collision with vessels is a cause of serious injury and mortality for large whales in some areas of the U.S., especially right whales in the North Atlantic. However, the exact number of these interactions is not known for other species since most whales struck and killed by vessels would tend to sink, rather than come inshore where they would be found. The proposed action is not likely to increase the number of vessel interactions since the research vessel would be stationary.

4.7.4 Other research permits

There are currently no other scientific research permits that authorize similar acoustic research in the Pacific. Although the research proposed by Dr. Stein in the North Pacific may be similar to some of the research authorized in Dr. Tyack's permit for the Atlantic (Permit No. 981-1707), there is no chance of cumulative impacts from the two permits since the researchers plan to work in different ocean basins. For the most part, marine mammals in the North Pacific do not travel to the Atlantic, or vice versa. Thus, any marine mammals affected by the Proposed Action would not likely be the same ones affected by Dr. Tyack's research.

NMFS has also issued scientific research permits for the other species or stocks listed in Table 1, excluding sea otters which are under the jurisdiction of the USFWS. The majority of "takes" under these permits are by "level B" harassment during aerial and vessel surveys conducted for census purposes. Under these permits, a limited number of cetaceans are also "taken" by remote biopsy sampling for genetic and contaminant studies and attachment of scientific instruments such as VHF or satellite tags to track their movements at sea. A small percentage of some pinniped species are also captured, have scientific instruments attached, and blood and tissue samples collected for health assessments and studies of foraging behavior. NMFS does not anticipate cumulative impacts from these permits in conjunction with the proposed action for a number of reasons. First, there is not likely to be direct overlap in time and space between any permits. All NMFS permits require permit holders to coordinate their field activities with other permit holders who may be conducting research in the same area or on the same species. The second reason cumulative impacts are not anticipated from research permits is that the duration of the proposed action is very brief and any effects on exposed marine mammals are expected to be short term. The same is also true of individual studies under other permits that authorize research on the same species or stocks.

4.7.5 Habitat degradation

Loss of habitat is a primary cause of the decline of many species worldwide. Habitat loss does not have to result from physical exclusion from an area (as can occur with some construction activities). Marine mammals may be indirectly affected by a variety of other human activities, including discharges from wastewater systems, dredging, ocean dumping and disposal, and aquaculture. In the North Pacific, undersea exploitation and development of mineral deposits, as well as dredging of major shipping channels pose a continued threat to the coastal habitat of right whales. Point-source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials and sewage effluent, potential oil spills, as well as substantial commercial vessel traffic, and the impact of trawling and other fishing gear on the ocean floor are continued threats to right whales in the North Atlantic.

The impacts from these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Studies of captive harbor seals have demonstrated a link between exposure to organochlorines (*e.g.*, DDT, PCBs, and polyaromatic hydrocarbons) and immunosuppression (Ross *et al*. 1995, Harder *et al.* 1992, De Swart *et al.* 1996). The impact of ocean contamination on the health of marine mammal populations has been investigated with increasing interest, with particular focus on chemicals that persist in the environment, such as the organochlorines. These chemicals tend to bioaccumulate through the food chain, thereby increasing the potential of indirect exposure to a marine mammal via its food source. During pregnancy and nursing, some of these contaminants can be passed from the mother to developing offspring. Contaminants like organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell, 1993; O'Shea and Brownell, 1994; O'Hara and Rice, 1996; O'Hara *et al.*, 1999).

4.7.6 Noise

Animals inhabiting the marine environment are continually exposed to many sources of sound. Naturally occurring sounds such as lightning, rain, subsea earthquakes, and animal vocalizations (*e.g.,* whale songs) occur regularly. The noise from airplanes and helicopters, recreational boating and commercial shipping, is a source of potential disturbance. 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, construction, geological explorations, etc. (Richardson *et al*., 1995). Most observations have been limited to short-term behavioral responses, which included cessation of feeding, resting, or social interactions. Several studies have demonstrated short-term effects of disturbance on humpback whale behavior (Baker *et al.* 1983; Bauer and Herman 1986; Hall 1982; Krieger and Wing 1984), but the long-term effects, if any, are unclear or not detectable. Marine mammals can be found in areas of intense human activity, suggesting that some individuals or populations may tolerate, or have become habituated to, certain levels of exposure to noise (Richardson *et al*., 1995). For example, baleen whales, including right whales, are consistently found within the shipping lanes of the St. Lawrence estuary and off Cape Cod despite frequent exposure to vessels. Such tolerance is likely related to the importance of the area to feeding and/or migrating whales and a certain degree of habituation. It is not clear whether such chronic exposure to anthropogenic noise has adverse physiological effects or whether potential masking of communication sounds is having negative impacts on social behaviors.

There is evidence that anthropogenic noise has increased the ambient level of sound in the ocean over the last 50 years. Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage. Commercial fishing vessels, cruise ships, transport boats, and recreational boats all contribute sound into the ocean. The military uses sound to test the construction of new vessels as well as for naval operations. In areas such as the Gulf of Mexico where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms. Currently 155 seismic survey vessels operate throughout the world with source levels of up 260 dB re 1 μPa at 1 m (far field estimate) or more. Hundreds of naval vessels operate high power sonars with source levels of 240 dB. Sonars used for depth sounding and bottom profiling often operate in the 1-12 kHz frequency band with source levels similar to that of the whale-finding sonar (Richardson *et al*.,1995). Most ships operate depth sounding sonars continuously while at sea and bottom profilers are a commonly used research tool. The annual operation of the whale-finding sonar in the propose research will involve a maximum of 120 hours per year of the permit. Comparable depth sounding and bottom profiling sonars are operated for millions of hours/year in this same location. Adverse impacts have not been observed from these sources, but there have been few studies looking in detail at exactly how marine mammals respond to them during their dives.

The marine mammals, sea turtles, and their prey that occur in the proposed study areas are regularly exposed to these types of natural and anthropogenic sounds. The cumulative effects of these activities cannot be predicted with certainty. Impacts may be chronic as well as sporadic effects like behavioral changes that can stress the animal and ultimately lead to increased vulnerability to parasites and disease (MMS 2000). The net effect of disturbance is dependent on the size and percentage of the population affected, the ecological importance of the disturbed area to the animals, the parameters that influence an animal's sensitivity to disturbance or the accommodation time in response to prolonged disturbance (Gerarci and St. Aubin 1980).

Considering the brief period over which the proposed research will occur (120 hours over a three to four week period in a year, with a 10% duty cycle), the limited geographic scope (especially compared to the sizes of the ranges of the species that may be affected), the short acoustic transmissions that will be broadcast, the conservative maximum received levels set, the mitigation measures that will be employed, and that these sound sources are not novel to the marine environment, the proposed research will contribute a negligible increment over and above the effects of the baseline activities currently occurring in the marine environment where the proposed research would occur.

4.8 Consideration of Significant Criteria

In the draft EA, NMFS considered the context and intensity of the factors identified in NOAA NAO 216-6 section 6.01b, as well as short and long term effects of the proposed action. Based on the analysis in the draft EA, NMFS finds that:

1. The proposed action is not expected to jeopardize the sustainability of any species that may be affected by the action. The effects of the proposed action would be limited to short-term disturbance of some marine mammals, which is not expected to result in effects on the species to which they belong.

2. The proposed action is not expected to allow substantial damage to the ocean and coastal habitats and/or Essential Fish Habitat (EFH) as defined under the Magnuson-Stevens Act and identified in Fishery Management Plans. The research activity described in the Proposed Action is directed at whales and is not likely to have any effects on the physical environment, including any EFH.

3. The proposed action is not expected to have a substantial adverse impact on public health and safety. Within the study areas there is little chance of human divers being in the area and mitigation measures are in place to prevent exposure to divers.

4. The proposed action is not expected to have a significant adverse impact on endangered or threatened species of marine mammals, and is not expected to affect designated critical habitat of these species.

5. The proposed action is not expected to result in cumulative adverse effects that could have a substantial effect on the target research species or non-target species. Since most if not all of the sound produced by the whale finder sonar would be inaudible to the gray whales, no significant adverse effects are anticipated for this species. The same is true for any other baleen whales that may be present. In the case of toothed whales, pinnipeds, and sea otters that could hear the sonar sounds, the duration of the study as well as rapid attenuation of the sonar sounds suggests nothing more than limited instances of avoidance or disturbance are likely.

6. The proposed action is not expected to jeopardize the sustainability of any non-target species. Any exposure of individual marine mammals to the sonar sounds will be of limited duration and would not likely result in population-level effects.

7. The proposed action is not expected to have a substantial impact on biodiversity and ecosystem function within the affected area (*e.g.*, benthic productivity, predator-prey relationships, etc.). The Proposed Action is of limited duration and geographic scope and is not likely to result in more than short-term behavioral responses of a limited number of individuals. These short-term responses are not likely to have a measurable effect on productivity, foraging, predator avoidance or other essential biological functions.

8. There are no significant social or economic impacts interrelated with significant natural or physical environmental effects.

9. Concerns were previously raised about a similar study by a small segment of the public and a research permit was permanently enjoined by a Federal court prior to initiation of any research activities because the court found that NMFS incorrectly invoked a categorical exclusion in issuing the permit. NMFS made a draft Environmental Assessment available for public review and comment concurrent with the application. NMFS held a public meeting to inform interested parties of the proposed research and solicit comments on the application and accompanying draft EA. No comments were offered by the public at the meeting. Three sets of written comments were received regarding the application and draft EA (see Appendix C). The primary concerns raised were similar in all three sets of comments. A fourth set of comments was received but did not relate to the substance of the application or draft EA. The MMC submitted comments in support of the study and recommended approval of the permit. For these reasons, the Proposed Action is not highly controversial to the extent that the preparation of an EIS is necessary.

Recommendation: It is recommended that the proposed action be determined not to have a significant impact on the quality of the human environment and that the preparation of an environmental impact statement not be required.

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APPENDIX A: BRIEF OVERVIEW OF THE PROCESS FOR OBTAINING A NMFS SCIENTIFIC RESEARCH PERMIT UNDER MMPA AND ESA

Persons seeking a special exception permit for scientific research must submit a properly formatted and signed application to the Office Director. The applicant must describe the species to be taken, the manner and duration of the takes, the qualifications of the researchers to conduct the proposed activities, as well as provide justification for such taking. Upon receipt, applications are reviewed for completeness according to the specified format and for compliance with regulations specified at 50 CFR §216.33. At this time, an initial determination is made as to whether the proposed activity is categorically excluded from the need to prepare an EA or EIS. A Notice of Receipt of complete applications must be published in the Federal Register. This Notice invites interested parties to submit written comments concerning the application within 30 days of the date of the Notice. At the same time, the application is forwarded to the MMC and other reviewers for comment. In addition, if endangered species are likely to be affected by the proposed activities, the Permits Division must consult with NMFS Endangered Species Division (or the U.S. Fish and Wildlife Service if species under their jurisdiction are involved). At the close of the comment period, the applicant may need to respond to requests for additional information or clarification from reviewers. If the proposed activities do not meet the criteria for a categorical exclusion, the appropriate environmental documentation (EA or EIS) must be prepared and is subject to public comment. If all concerns can be satisfactorily addressed and the proposed activity is determined to be in compliance with all relevant issuance criteria (see sections 1.5.2 and 1.5.3), the Office Director will issue a permit.

MMPA regulations regarding issuance of Scientific Research Permits (SRPs)

The regulations promulgated at 50 CFR §216.33, §216.34, and §216.41 specify criteria to be considered by the Office Director in making a decision regarding issuance of a permit or an amendment to a permit. Specifically, §216.33(c) requires that the Office Director (a) make an initial determination under NEPA as to whether the proposed activity is categorically excluded from preparation of further environmental documentation, or whether the preparation of an environmental assessment (EA) or environmental impact statement (EIS) is appropriate or necessary; and (b) prepare an EA or EIS if an initial determination is made that the activity proposed is not categorically excluded from such requirements. The permit issuance criteria listed at §216.34 require that the applicant demonstrate that:

(1) The proposed activity is humane and does not present any unnecessary risks to the health and welfare of marine mammals.
(2) The proposed activity is consistent with all restrictions set forth at §216.35 and any purpose-specific restrictions as appropriate set forth at §216.41, §216.42, and §216.43.
(3) The proposed activity, if it involves endangered or threatened marine mammals, will be conducted consistent with the purposes and policies set forth in section 2 of the ESA.
(4) The proposed activity by itself or in combination with other activities will not likely have a significant adverse impact on the species or stock.
(5) The applicant's expertise, facilities, and resources are adequate to accomplish successfully the objectives and activities stated in the application.

(6) If a live animal will be held captive or transported, the applicant's qualifications, facilities, and resources are adequate for the proper care and maintenance of the marine mammal.
(7) Any requested import or export will not likely result in the taking of marine mammals or marine mammal parts, beyond those authorized by the permit.

In addition to these requirements, the issuance criteria at §216.41(b) require that applicants for permits for scientific research and enhancement must demonstrate that:

(1) The proposed activity furthers a *bona fide* scientific or enhancement purpose.
(2) If the lethal taking of marine mammals is proposed:
(a) Non-lethal methods for conducting the research are not feasible; and
(b) For depleted, endangered, or threatened species, the results will directly benefit that species or stock, or will fulfill a critically important research need.
(3) Any permanent removal of a marine mammal from the wild is consistent with any applicable quota established by the Office Director.
(4) The proposed research will not likely have significant adverse effects on any other component of the marine ecosystem of which the affected species or stock is a part.
(5) For species or stocks designated or proposed to be designated as depleted, or listed or proposed to be listed as endangered or threatened:
(a) The proposed research cannot be accomplished using a species or stock that is not designated or proposed to be designated as depleted, or listed or proposed to be listed as threatened or endangered;
(b) The proposed research, by itself or in combination with other activities will not likely have a long-term direct or indirect adverse impact on the species or stock;
(c) The proposed research will either:
(i) Contribute to fulfilling a research need or objective identified in a species recovery or conservation plan, or if there is no conservation or recovery plan in place, a research need or objective identified by the Office Director in stock assessments established under Section 117 of the MMPA;
(ii) Contribute significantly to understanding the basic biology or ecology of the species or stock, or to identifying, evaluating, or resolving conservation problems for the species or stock; or
(iii) Contribute significantly to fulfilling a critically important research need.

ESA regulations regarding issuance of SRPs

NMFS' regulations implementing the ESA at 50 CFR §222.308(b) provide that "Permits for marine mammals shall be issued in accordance with the provisions of part 216, subpart D of this chapter" as outlined in the previous subsection of this EA. In addition to these issuance criteria under the MMPA, NMFS' regulations implementing the ESA at 50 CFR §222.308(c) require that the following criteria be considered in determining whether to issue a permit for scientific purposes for takes of endangered species:
(1) Whether the permit, if granted and exercised, will not operate to the disadvantage of the endangered species;

(2) Whether the permit would be consistent with the purposes and policy set forth in section 2 of the ESA;

(3) Whether the permit would further a *bona fide* and necessary or desirable scientific purpose or enhance the propagation or survival of the endangered species, taking into account the benefits anticipated to be derived on behalf of the endangered species;

(4) Whether alternative non-endangered species or population stocks can and should be used;

(5) Whether the expertise, facilities, or other resources available to the applicant appear adequate to successfully accomplish the objectives stated in the application; and

(6) Opinions or views of scientists or other persons or organizations knowledgeable about the species which is the subject of the application or of other matters germane to the application.

Under section 7 of the ESA, the Permits Division, as a Federal action agency, is required to determine whether issuance of a permit may affect listed species or critical habitat. If it is determined that issuance of a permit may adversely affect listed species or adversely modify critical habitat, the Permits Division must formally consult with the Endangered Species Division. In requesting this consultation, the Permits Division is required to provide the best scientific and commercial data available for an adequate review of the effects of the proposed permit on listed species and critical habitat (50 CFR §402.14). Although both the MMPA and ESA definition of a "take" include harassment, the ESA does not define harassment. However, harassment has been defined in Biological Opinions prepared during consultations on issuance or marine mammal research permits, as injury to an individual animal or population of animals resulting from a human action that disrupts one or more behavioral patterns that are essential to an individual animal's life history or to the animal's contribution to a population, or both. Particular attention is given to the potential for injuries that may manifest themselves as an animal that fails to feed successfully, breed successfully (which can result from feeding failure), or complete its life history because of changes in its behavioral patterns. In the latter two of these examples, the injury to an individual animal could be injurious to a population because the individual's breeding success will have been reduced.

APPENDIX B: GLOSSARY OF ACOUSTICS TERMINOLOGY

Behavioral Response and Habituation: Sounds can result in short-term behavioral responses that range from changes in movement patterns that can only be detected through sophisticated statistical analysis, to more dramatic actions such as marine mammal breaching, rapid swimming, and temporary or permanent displacement from an area. Response is not narrowly predicable and can vary with sex, age, social context and season. Infrequent and minor changes in movement directions, for example, may be completely benign, while recurrent incidents of interrupted feeding and rapid swimming, if sufficiently frequent and of prolonged duration, could have negative effects on the well-being of individuals. Behavioral changes generally are detected at sound intensities higher than the levels at which masking (see below) could occur.

Best frequency: The best frequency is the frequency with the lowest hearing threshold for a particular species, that is, the best sensitivity (Richardson *et al*., 1995).

Direct Damage to Major Hearing Structures: Extreme types of hearing effects are pressure-induced injuries associated with explosions or blunt cranial impacts that cause an eruptive injury to the inner ear (frequently coinciding with fractures to the bony capsule of the ear or middle ear bones and with rupture of the eardrum or round window). These injuries are not acoustically-induced, thus, this kind of damage will not occur under the proposed research.

Hearing threshold: The level of sound that is barely audible in the absence of significant ambient noise is the absolute hearing threshold. It is the lowest sound level that is detected during a specific percentage of experimental trials. A statistical definition is necessary because, even for a single animal, the minimum detectable sound level varies over time (Richardson *et al*., 1995).

Masking: Increases in noise levels can decrease the ability of an animal to detect biologically important sound when the increased noise level rises above the level of sound for which the animal is listening. This effect is commonly known as masking. Masking of significant sounds (*e.g*., calls of other animals, predators, sounds of hazards, such as approaching boats, etc.) can occur when ambient noise levels increase. Marine mammals have evolved in the highly variable noise environment of the ocean, and presumably are well adapted for tolerating the natural variations in ocean noise that could at times cause masking. However, the determination of an animal's ability to tolerate changes in noise levels requires a better understanding of: 1) the functional importance of faint sound signals from the same species, predators, prey, and other natural sources; 2) signal detection abilities of marine mammals in the presence of background noise, including directional hearing abilities at frequencies where masking is an issue; and 3) abilities of marine mammals to adjust the intensities and perhaps frequencies and timing of emitted sounds to minimize masking effects.

Permanent Threshold Shift (PTS): an increase in the threshold of hearing that is permanent, not temporary. It is an unrecoverable deafening due to physiological damage to the hearing organs that does not diminish with time. PTS may occur as a result of long-term exposures and/or extremely loud noises. Repeated exposures that cause to temporary threshold shift (TTS) can induce PTS, as well. The mitigation measures proposed for implementation under the proposed research and discussed in the EA are designed to ensure that PTS does not occur from experiments under the proposed research.

Temporary Threshold Shift (TTS): a brief, transitory increase in an individual animal's hearing threshold in response to exposure to sound. All humans typically experience such shifts, such as the effect that occurs after leaving a noisy room for a quiet location. For a period of time, hearing sensitivity is decreased such that quiet sounds are not perceived. TTS recovers so that original hearing abilities return. Minor amounts of shift (3-5 dB) may recover in minutes; large shifts (40 dB) may recover overnight, and major shifts (>45 dB) may require days or weeks to recover. Above 65 dB the shift may not fully recover. TTS generally occurs in a limited or affected frequency band at sound intensities well above hearing threshold levels. Using NMFS interim guidance (based on human hearing data), the difference between the threshold of hearing and sound intensities that result in annoyance (or possibly TTS) in marine mammal is approximately 80 to 100 dB. For the experiments covered by this assessment, the more conservative value of 80 dB above threshold will be used throughout. NMFS nevertheless notes that at this time, exposures that cause PTS or TTS have not been measured for mysticetes or sperm whales.

APPENDIX C: COMMENTS RECEIVED ON APPLICATION AND DRAFT EA

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