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REF:OCEA

File No.: KA-2734

Dr. Andrew Forbes
ATOC Deputy Director
Scripps Institution of Oceanography
9500 Gilman Drive
La Jolla, California 92093-0225

JUN 13 1995

Dear Dr. Forbes:

We have completed our review on your Final EIS submitted on May 16, 1995.

The judgment in question is whether the Final EIS is an acceptable or non-acceptable document under Chapter 343 Hawaii Revised Statutes, as amended.

As we represented earlier, in our view, acceptance means that the document fulfills the definition of an Environmental Impact Statement (EIS), adequately describes identifiable environmental impacts, and satisfactorily responds to comments received during the review of the statement.

The EIS means to us that an <u>informational</u> document has been prepared in compliance with the rules and regulations promulgated under Chapter 343-5 and which discloses the environmental effects of the proposed action, effects of the proposed action on the economic and social welfare of the community and State, effects of the economic activities arising out of the proposed action, measures proposed to minimize adverse effects and alternatives to the action and their environmental effects.

We are of the opinion that a major purpose in accepting or not accepting a statement, as suggested under Title 11, Chapter 200 of the <u>Administrative Rules</u>, is that the document adequately <u>discloses environmental impacts</u> and satisfactory <u>responds to comments</u>.

Considering our focus on the requirements for information and disclosure as having been adequately met; we find the document <u>acceptable</u> under Chapter 343 Hawaii Revised Statutes, as amended and the <u>Hawaii Administrative Rule</u>.

In our view, the document, in and of itself, should not be used as a vehicle to promote or detract from any required subsequent judgment on the proposed ATOC project itself. We have consistently maintained this posture in the past.

In addition, we should point out that the acceptability of this statement is based upon criteria set forth, and, as such we nevertheless have concerns relating to the substance within the document itself. As such, these concerns relating to substance will be addressed in the analysis of Conservation District Use Application (CDUA) No. KA-2734.

If you have any questions, please feel free to contact Roy Schaefer of my staff at (808) 587-0377.

Aloha,

MICHAEL D. WILSON, Chairperson

c: OEQC

1995 FEIS KAUAI
KAUAI OFFSHORE ACOUSTIC THERMOMETRY OF OCEAN CLIMATE (ATOC) 1 OF 2

FILE COPY

Final
Environmental Impact Statement
for the
Kauai Acoustic Thermometry of Ocean Climate Project
and its associated
Marine Mammal Research Program
(Scientific Research Permit Application [P557C])
Hawaii Conservation District Use Permit Application [KA2734]

Volume I

Prepared by

Advanced Research Projects Agency
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and
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Office of Protected Resources
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State of Hawaii
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Department of Land and Natural Resources
Office of Conservation and Environmental Affairs
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May 1995

Printed on Recycled Paper

Preface

In response to several requests by the public for an opportunity for additional participation in the EIS review and approval process, comments from the public are being solicited during the 30-day period ending June 26, 1995, following official publication of the Final EIS via the Federal Register. Written comments should be submitted to:

Advanced Research Projects Agency
c/o Clayton H. Spikes
Marine Acoustics, Inc.
Four Crystal Park, Suite 901
2345 Crystal Drive
Arlington, VA 22202

Title

Final Environmental Impact Statement (EIS) for the Kauai Acoustic Thermometry of Ocean Climate (ATOC) Project and its associated Marine Mammal Research Program (MMRP) (Scientific Research Permit Application [P557C]; Hawaii Conservation District Use Permit Application [KA2734]).

Abstract

ATOC is proposed as a proof-of-concept study funded by the Strategic Environmental Research and Development Program (SERDP). The primary purpose of ATOC is to make a contribution toward meaningful climate predictions. All viable climate models show that the ocean plays a profound role in climate change. The ocean provides much of the memory which defines climate. No climate forecast, with all its consequences, will have any skill greater than that imbedded in the oceanic component. One will not get the atmosphere right unless one gets the ocean right.

The question is whether these forecasts have any skill; i.e., whether they provide a reasonable basis for policy decisions. We know from experience with weather forecasting that meaningful forecasts are impossible unless the system is correctly described by the equations being used, and then "initialized" properly; i.e., the calculations must be started from a realistic oceanic state--otherwise, the forecast diverges rapidly from reality.

Perhaps the greatest obstacle to making useful forecasts of the ocean climate lies with the difficulty in measuring the ocean state today so as to test the models against present-day reality, and in determining the extent to which the ocean is already changing. Appropriate ocean measurements are then an essential part of any climate prediction. ATOC is intended to observe the ocean on the large space scales that characterize climate--3000 to 10,000 km--so that modelers will be able to: 1) test their models against the changes seen by ATOC over a few years, and 2) if, and when, the models prove adequate, use those same observations to "initialize" the models to make climate predictions.

Acoustic thermometry would provide important tests of seasonal and year-to-year ambient variability. Interplay of the observational and modeling efforts should lead to model improvements and, ultimately, to model credibility. By testing and improving the models now, we can make progress toward greenhouse prediction later.

Virtually all climate models suggest that there will be major shifts in climate over the next several decades ("global warming"), with enormous consequences to the world's economic, social and environmental structures (including life within the seas). Acoustic thermometry can make a contribution toward credible climate predictions.

The 1991 Heard Island Feasibility Test proved the principle of using low frequency acoustic signals of moderate intensity over global deep ocean transmission paths to measure propagation time and spatial variability of temperature.

Available information from the limited research carried out to date on the potential effects of low frequency sound on marine animals, including marine mammals and sea turtles, either indicates minimal impact should be expected from the proposed ATOC sound transmissions, or the measured data are so sparse that the possible effects must be stated as uncertain. Consequently, a Marine Mammal Research Program (MMRP) has been designed to assess the potential effects of the proposed low frequency sound transmissions on marine mammals and sea turtles. MMRP research efforts would be an integral part of the entire proposed two-year project, including ATOC feasibility operations that would be dedicated to climate-based studies. An approximate six-month MMRP Pilot Study (although MMRP refers to the Marine Mammal Research Program, all marine animals fall within its purview, including sea turtles) would be undertaken, which would allow marine biologists to utilize the source for research studies into the potential effects of low frequency sound on marine animals, prior to approval of feasibility operations. Baseline marine animal population and behavioral data collection efforts have been ongoing in the north Kauai offshore area since 1993.

In accordance with Marine Mammal Protection Act and Endangered Species Act guidelines, an Application for Permit for Scientific Research has been submitted to the National Marine Fisheries Service. Because of potential environmental concerns, this EIS has also been prepared.

Hawaii Environmental Policy Act (HEPA) Summary Sheet

This joint federal/state Draft Environmental Impact Statement (DEIS) addresses the Kauai, Hawaii Acoustic Thermometry of Ocean Climate Project and its associated Marine Mammal Research Program. The proposed Kauai facilities would include an acoustic sound source to be located 14.7 kilometers (km) (8 nautical miles (nm)) offshore at an approximate depth of 850 meters (m) (about 3000 feet or half a mile down). The sound source would transmit a 260 watt acoustic output, digitally coded sound, between 2% and 8% of the time, with a center frequency of 75 Hz (cycles per second) and a bandwidth of approximately 35 Hz. The sound would be a low rumble, with a pitch comparable to the low notes of a cello. This project is also funding an extensive Marine Mammal Research Program to address the question of whether long-term underwater low frequency acoustic transmissions are safe for marine animals (particularly marine mammals and sea turtles).

Potential environmental effects of the project include possible behavioral changes in humpback whales. The 120 dB sound field (7.5 to 12 km around the source) is equivalent to levels found in scientific studies to sometimes produce detectable changes in swim direction in several large whales. Similar effects could possibly occur in sperm whales and leatherback sea turtles, although low frequency hearing capabilities in these animals have not been documented. Beneficial effects of the project include the additional scientific knowledge about the potential effects of low frequency sound on marine animals, and evaluation of the proposed concept as a practical method for measuring basin-scale ocean temperatures.

This DEIS includes 23 mitigation measures. Among the most significant are the following: A dedicated MMRP Pilot Study would precede acoustic thermometry climate-related feasibility operations; the sound source would operate at the minimum power level and duty cycle (operational periods) necessary to support MMRP objectives and feasibility operations; all sound transmissions would be preceded by a five-minute ramp-up period starting at zero source level to allow time for any mobile marine animal who was annoyed by the sound to depart the affected area; and project facilities would be removed at the end of the experiment, to the extent economically and practicably feasible.

The alternatives considered include: the proposed action; no action; alternate project sites (four such sites are screened; including sites off the coast of Kauai, Midway Island, Johnston Atoll, and the Aleutian Islands); moored autonomous sources; restricted source transmission times; modified source operational characteristics; global climate models; satellite sensors for sea surface temperature measurements; satellite sensors for sea level measurements; oceanographic point sensors (measurements using conventional thermometers); autonomous polar hydrophones; and a dual site experiment using mobile playback experiments. Of the twelve alternatives considered, the proposed action (Kauai), no action, one alternate site (Johnston Atoll), and moored autonomous sources were selected for detailed consideration.

The unresolved issues concerning the project primarily result from: 1) the general lack of information concerning the potential effects of low frequency sounds on marine animals and 2) the potential constraints tides, internal waves and mesoscale thermal variations may impose on acoustic thermometry measurements. The MMRP is designed to help fill the gaps in the former; the acoustic thermometry feasibility operations (climate study) should respond to the latter.

The proposed project, its physical facilities, and the MMRP, are analyzed in relation to applicable plans and policies in Section 5 of this EIS. It is concluded that the proposed project is consistent with such plans and policies, including the Hawaii Coastal Zone Management Program, Hawaii Ocean Resources Management Plan, and the recovery plan for the humpback whale. Required approvals for the project include: a Scientific Research Permit from the National Marine Fisheries Service, a Conservation District Use Permit from the Hawaii Board of Land and Natural Resources, various nationwide permits from the U.S. Army Corps of Engineers, and other reviews and consultations described more fully in Section 5.

Federal Lead Agencies:	Advanced Research Projects Agency 3701 North Fairfax Drive Arlington, VA 22203-1714
	National Oceanic and Atmospheric Administration National Marine Fisheries Service Office of Protected Resources 1315 East-West Highway Silver Spring, MD 20910
State Accepting Authority:	Department of Land and Natural Resources Office of Conservation and Natural Resources Office of Conservation and Environmental Affairs 1151 Punchbowl Honolulu, HI 96813
Applicant:	University of California, San Diego Scripps Institution of Oceanography Institute for Geophysics and Planetary Physics 8604 La Jolla Shores Drive La Jolla, CA 92037

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EXECUTIVE SUMMARY

This Executive Summary describes the proposed action and alternatives analyzed in this Environmental Impact Statement (EIS) for the Kauai Acoustic Thermometry of Ocean Climate (ATOC) Project and its associated Marine Mammal Research Program (MMRP). This EIS presents a detailed description of the proposed project, its facilities, environmental setting, alternatives, environmental impacts, and mitigation measures, in addition to other information required by the National Environmental Policy Act (NEPA) and Chapter 343, Hawaii Revised Statutes, the Hawaii Environmental Policy Act (HEPA).

Under NEPA, the National Marine Fisheries Service (NMFS) and the Advanced Research Projects Agency (ARPA), must ensure that the potential environmental impacts of the proposed project have been adequately addressed and analyzed. In addition, other agencies will review and consider the information presented in this EIS prior to deciding whether to approve aspects of the project under their specific jurisdiction. These required approvals include: a Scientific Research Permit (SRP) from the National Marine Fisheries Service (NMFS), a Conservation District Use Permit (CDUP) and authorization to install project facilities on state lands from DLNR, a permit under Section 10 of the Rivers and Harbors Act under nationwide authorizations of the Army Corps of Engineers, and various other reviews and consultations described more fully in Section 5.

PROPOSED ACTION

Introduction

The overall ATOC project is an international research effort to observe the ocean on the large space scales (3000 to 10,000 km) which characterize climate, which will enable climate models to be tested against the average ocean temperature changes seen by ATOC over a few years and if, and when, the models prove adequate, use those same observations to "initialize" the models to make meaningful predictions.

The basic principle behind ATOC is simple. Sound travels faster in warm water than in cold water. The travel time of a sound pulse from a source near Kauai to a receiver near Guam, for example, will decrease if the ocean in between warms up and will increase if the ocean cools down. The travel time is a measure of the large-scale average temperature between the source and receiver. Measuring average ocean temperatures is necessary to validate global climate computer models being used and developed to answer the question of whether our earth is warming as a result of the "greenhouse" effect.

The proposed ATOC system takes advantage of an acoustic "waveguide" deep within the ocean that carries subsea sounds over very long distances. This feature, known as the "sound channel" or sound fixing and ranging (SOFAR) channel, is at the ocean depth where the speed of sound is at a minimum. Above the sound channel, sound travels faster because the water is warmer. Below the sound channel, sound travels faster because the pressures are greater. Sounds that would otherwise spread to higher or lower depths are refracted (bent) back toward the sound channel axis by this difference in speeds. The net effect is that the sound channel very efficiently transmits sounds for long distances. This effect also tends to limit sounds that are trapped in the channel from being detectable at depths outside of the channel.

The sounds to be produced by the ATOC sources are digitally coded, low frequency rumbles at a pitch comparable to the low notes of a cello. The same digital sequences are repeated a number of times and combined at the receivers. This allows a signal to be detected beneath the ambient background noise which, in turn, permits use of a less intense sound source. The receiving stations use advanced digital processing techniques similar to those used to retrieve data from deep space probes, to detect the signals after traveling great distances through the sound channel.

The ATOC Feasibility Demonstration

The proposed ATOC project is a 2-year demonstration or "proof of concept," with the goal of testing the acoustic thermometry concept, led by Dr. Walter Munk (Principal Investigator), Dr. Peter Worcester and Dr. Andrew Forbes, all of Scripps Institution of Oceanography, UCSD, and Dr. Robert Spindel, of the Applied Physics Laboratory at University of Washington. A previous test in 1991, called the Heard Island Feasibility Test, confirmed that low frequency sounds broadcast in the deep sound channel can be detected over great distances. Yet, whether the ATOC technique will provide useful climatic information depends on surmounting a number of technical and other potential barriers. For example, ocean movements from tides, currents, internal waves, eddies, and other oceanographic features also affect acoustic transmissions. While traveling long distances, sounds could be scattered, distorted or otherwise rendered unusable. The project analyzed in this EIS is of necessity limited to this next step--testing the ATOC concept to determine whether it should be pursued further.

Two sound sources are currently proposed for this 2 year demonstration project. One would be located offshore of central California on Pioneer Seamount, as described in detail in the California Final EIS/EIR, and the other would be located off the north shore of Kauai, Hawaii, and is the subject of this EIS. It is proposed to operate these sound sources from 2% to 8% of the time (they would be silent from 92% to 98% of the time), with the current project scope being limited to approximately two years.

Each source would be used to transmit low frequency, digitally coded sounds across the North Pacific ocean basin (at sound levels below ambient conditions along most of the path) to receiving stations around the North Pacific rim, most of which are existing facilities. Two new hydrophone receiver arrays are planned along the radial from Pioneer Seamount to Rarotonga (New Zealand territory), at approximately 3000 km and 6000 km range from Pioneer Seamount. This network would be complemented by up to ten drifting receivers deployed along selected transmission paths.

The proposed Kauai facilities would include a 260 Watt output acoustic sound source to be located 14.7 km (8 nm) offshore at a depth of approximately 850 m (2790 ft). This source would be powered by a cable connected to a signal source and power amplifier in an existing building at Barking Sands.

Following this initial 2 year demonstration period, any future facilities or operations would be subject to additional environmental review and authorization. The lessons learned from the demonstration phase would support all facets of future global climate change research planning: whether the program will proceed; if so, where facilities will be located, equipment design, sound levels, mitigation measures, etc. Since it is not presently known what would be learned from the demonstration phase, the particulars of any future activities can only be speculated on at this time.

The Marine Mammal Research Program

An integral part of the proposed feasibility demonstration is an extensive marine mammal research program (MMRP) to evaluate the potential effects of the proposed low frequency acoustic transmissions on sea life, particularly marine mammals, but also including sea turtles, fish and invertebrates. It is known, for example, that large whales vocalize (and presumably can hear well) in the low frequency range, similar to that used by the ATOC system. Yet very little is known about the effects of low frequency noise on marine mammals.

The 2-year Kauai MMRP is directed by Dr. Christopher W. Clark, Director of Cornell University's Bioacoustic Research Program. The sound source would initially be controlled by the MMRP Research Team, manipulating the signal strength (power level) and duty cycle (repetition rate) of the source for a period of several months. Climate-related transmissions would only begin if the system is determined to have no acute or short-term effects (Table C-1) on marine animals. The Pilot Study, if successful, would determine whether and, if so, how best to continue the project. A detailed description of the MMRP protocol is included in Appendix C of this EIS/EIR.

In addition to providing information on marine mammals, the MMRP would serve a protective function by monitoring for any adverse impacts of the source transmissions. This function would continue throughout the approximate two year experimental period. During the Pilot Study, source transmissions would stop if the marine biologists observe adverse effects meeting the source termination guidelines of Appendix C. Assuming the experiment proceeds, MMRP research would continue, with the source termination protocols in effect (subject to any modifications resulting from the Pilot Study) throughout the remainder of the experiment.

AREAS OF CONCERN

The ATOC proposal has generated an extraordinary level of public attention. Concerns have centered on three principal areas:

- Potential effects of low frequency sounds on marine mammals, sea turtles and other marine life.

- Alternative technologies to conduct climate change studies.

- Whether the ATOC project is an appropriate activity at the proposed location.

Attention has been focused on the potential effects of subsea noise on marine animals, and on the lack of available information in the scientific community. The debate also led to the reevaluation of the project and the incorporation of a number of changes:

- A nearly four-fold reduction in the proposed transmission schedule (from the original proposal to broadcast 8% of the time to the current proposal to broadcast 2% of the time for most of the experimental period).

- A reemphasis of the program structure; i.e., the MMRP Pilot Study would be conducted prior to any ATOC *climate-related sound transmissions*, and its results used to determine whether the study should go forward.

- The preparation of this EIS to better involve the public in the proposal and to develop additional mitigation measures.

POTENTIAL IMPACTS ON MARINE LIFE

The ATOC sound source would transmit a 260 Watt acoustic output, digitally coded sound with a center frequency of 75 Hertz (Hz, or cycles per sec) and a bandwidth of approximately 35 Hz (i.e., sound transmissions will be in the frequency band of 57.5-92.5 Hz).

At 1 m (slightly more than 3 ft) from the source, the sound intensity level would be approximately 195 decibels (dB) referenced to one microPascal (μPa) on a "water standard" basis. At a distance of 30 m (about 100 ft), the level is 30 dB less, or 165 dB. At 1000 m (0.5 nm), the level is down to 135 dB. Unless otherwise noted, all sound levels in this EIS are referenced to water standard.

The decibel value for sound in water is 61.5 dB higher than for sound with equivalent power levels in air (which are referenced to 20 μPa), a relationship that is explained in greater detail in Section 1.1.4. A 260 Watt acoustic output produces a 133.5 dB sound level (air standard) at 1 m distance, a 103.5 dB sound level (air standard) 30 m away, and a 73.5 dB sound level (air standard) 1000 m away. An air standard level of 58.5 dB is equivalent to the 120 dB water standard level which has produced some detectable changes in the behaviors of certain marine mammals. Table ES-1 summarizes the relationship of sound levels for some common sounds in both air and water.

Average ambient noise levels in the 60-90 Hz band offshore Kauai are estimated to be in the 76-98 dB range for sea state 2-6, and are expected to be higher (≥120 dB) when vessels are present (Buck and Chalfant, 1972; Ross, 1976; Brown, 1982b). Transmissions from the proposed sound source at the water's surface are expected to be 135 dB at a radius of 1000 m (received level is not expected to exceed 136 dB at the water's surface anywhere in the vicinity of

Range from ATOC Source	dB (water standard)	dB (air standard)	Comparable Sounds
1 m (approximately 3 ft)	195	133.5	Container ship at comparable distance. Very high powered loudspeaker system at comparable distance. Ambulance siren at comparable distance.
30 m (approximately 100 ft)	165	103.5	Large ship at comparable distance. Rock concert (comparable to sounds 200-400 ft from ATOC source). Jet airliner (10 m) Ambulance siren (somewhat closer than 34 m). "Very loud"
1000 m (sea surface above ATOC source)	135	73.5	Small power boat. Freeway 34 m away. Beluga whale threshold (1000 Hz). "Moderately loud"
7.5-12 km (4-6.5 nm)	120	58.5	Sea sounds (wind and wave action) during storm. Normal speech (1 m)
55 km (30 nm)	110	48.5	Symphony orchestra at 6 m (20 ft) Heavy surf on beach at 1 m (3 ft) Heavy truck (64 km/hr) at 15 m (50 ft)

Table ES-1. Relationship of sound level of common sounds in air and water (20-1000 Hz) the source); 130 dB to a radius of 5 km; 120 dB at 12 km shoreward and 7.5 km seaward; and 110 dB to 55 km seaward. Underwater sound levels are expected to be: 140 dB at 288 m depth (562 m range around source); 145 dB at 534 m depth (316 m range around source); 150 dB at 672 m depth (178 m range around source); 165 dB at 820 m depth (30 m range around source); and 195 dB at 850 m depth (1 m range around source) (see Section 2, Figure 2.2.1-6).

Within the study area, there are no applicable undersea noise standards. Most land-based community noise standards use average measurements that weigh various time periods throughout the day differently (e.g., nighttime hours), due to the greater relative sensitivity of the human population that may be exposed to the noise at those times. However, for determining the significance of the sound from the ATOC source, a long-term average, or level-equivalent (Leq) is considered the most appropriate by some acoustic researchers. The ATOC source operation would transmit on a 2% duty cycle for most of the time and would not emphasize any time of day or night and, although some marine animals exhibit diurnal activity patterns, in general there are no particular hours of the day that should be of greater concern in the marine environment. Using the scientifically accepted formula for determining Leq, the net value for exposure to the 120 dB sound field is calculated in Section 4. For a 2% duty cycle (20-min signal transmissions six times per day, every fourth day), Leq = 103 dB, which falls within the range of high ambient noise levels expected in the study area.

The significance of the subsea sounds from the ATOC source also depends upon the species that may be exposed, their population density, their diving behavior or likelihood of exposure, and their hearing sensitivity. For some species, the most important variable may be the types and functions of the sounds produced by the animals, and how production and use of those sounds may potentially be affected by ATOC sound transmissions. Most of this EIS is devoted to detailed discussions of these questions for the range of species that might be affected. Section 4 presents a detailed analysis of these impacts, and summarizes the results for each category of marine animals at the end of each subsection. Therefore, only a broad summary of conclusions will be presented here.

Mysticetes are believed to have good low frequency (<90 Hz) hearing, but no species are known to dive as deep as 670 m. Therefore, encounters with high intensities of the source transmissions would be expected to be rare inasmuch as the received sound level is not expected to exceed 136 dB at the water's surface anywhere in the vicinity of the source and the 135 dB sound field would encompass a radius of 1000 m around the source. It is expected that the use of the 5 min ramp-up procedure and limited duty cycle would mitigate potential impacts. All whale vocalizations detected by passive acoustic arrays would be recorded and analysed.

Only one large whale -- the humpback -- is commonly found in the vicinity of the proposed source site. Since it is believed that the humpback cannot dive as deeply as the source, it would not be exposed to the full 195 dB source level (at 1 m range). Sonar observations have shown humpback whales to dive as deep as 200 m (Whitehead, 1981) while pursuing prey, but Dolphin (1987a) stated that such efforts may put them into oxygen debt, and they probably rarely descend deeper than 60 m. Using the 200 m depth, the maximum sound levels experienced by humpbacks would be over 350,000 times less than 195 dB, or 138 dB. This level is below that anticipated to produce any type of direct auditory injury or effect (e.g., permanent threshold shift [PTS] or temporary threshold shift [TTS]). Instead, it is anticipated that any effects would be limited to potential behavioral changes. For analysis purposes in this EIS, it as assumed that the common maximum diving depth for humpbacks is 150 m.

In the general area of the proposed sound source off Kauai, most of the humpback whales (>73%) tend to stay within the 100 fathom (200 m) depth contour, close to shore. Based on 1993 and 1994 MMRP baseline surveys and observations of humpbacks north of Kauai, when humpbacks are present in Kauai waters (November - May), it appears that on average 0-5 humpback whales could be found within the 120 dB sound field area during any given sound transmission. Data from the studies indicate that most individual humpbacks probably remain in the Kauai project area for relatively brief periods, in contrast to the waters around Maui that experience much higher concentrations of the whales, which remain for more extended periods.

Sperm whales and some beaked whales are capable of diving to > 800 m depth; the former may have some low frequency hearing capability. Thus these species could be affected by passage through the sound fields, although encounters with high intensities would be expected to be rare. It is expected that the use of the 5 min sound ramp-up procedure and limited duty cycle would mitigate potential impacts.

Statistical analysis based on conservative assumptions and a random distribution gives the estimate that, with a 2% duty cycle, one sperm whale might be exposed to greater than 150 dB levels once during a two-year period. Sperm whales are a focus of MMRP research and, as noted above, all whale vocalizations detected by passive acoustic arrays would be recorded and analysed.

Other odontocetes are not known to dive to sound field depths and/or to have low frequency hearing. Therefore, potential impacts from the sound source are expected to be minimal for these species.

The only pinniped in the area, the endangered Hawaiian monk seal, probably has poor low frequency hearing. Recent data from a seal tagged with a time-depth-recorder (TDR) indicated it dove at least once to 500 m, which was the limit of the TDR (Ragen, pers. comm., 1995). Although monk seals are seen around Kauai, most of the population inhabits the northwestern Hawaiian Islands, where the project source would be inaudible to them. There are at least 2-3 resident animals on Kauai (Nitta, pers. comm., 1995). There were, among others, 3 sightings around the island in 1993--none off the north shore; and one sighting off the north shore during 1994 MMRP shore-based visual surveys (Smultea et al., 1994). Although any level of physiological impact on this endangered species would be considered adverse, there is little likelihood of such an occurrence.

Concerning sea turtles, maximum diving depths for leatherbacks are >1000 m. No other species of sea turtle are known to dive >500 m. Leatherbacks may be sensitive to low frequency sound. However, densities are presumed low in the Kauai area, and it is expected that the 5-min ramp-up and limited duty cycle would mitigate potential effects.

There is potential for auditory injury for individuals of any species of fish located where received sound levels are at or above 180 dB (Hastings, 1991), which equates to a radius of about 8 m around the source. However, given that the 5-min ramp-up period may allow sufficient time for fish to depart the area prior to onset of the main transmission, and the small volume involved for the 180-195 dB level, potential impacts on fish populations would be expected to be minimal. Most pelagic fish species should be far enough away from the proposed source site to experience no impacts from the source transmissions. Similarly, those species inhabiting the areas below the depth of the source (i.e., >850 m) should receive less exposure (approximately 5-10 dB less).

Sharks likely are the species of fish most vulnerable to potential effects from low frequency sound transmissions. Sharks hear best in low frequencies below 300 Hz and, in fact, seem to be attracted to low frequency sounds, which they may use as a means of locating prey. Because sharks are known to be attracted to low frequency signals, they would appear to be one of the best candidates for incurring some level of auditory (i.e., TTS) and/or behavioral disruption due to the ATOC source transmissions. However, based on studies by Nelson and Johnson (1972), sharks readily habituated to low frequency, pulsed sounds. Thus, it might be that the attractiveness of the ATOC source emanations would wane over a period of time, given its more constant transmission characteristics, at duty cycles (transmission periods) of 2-8%. For the three species of shark for which audiograms are available (horn, lemon, bull) hearing thresholds in the 75 Hz range were from 99-103 dB, equating to potential masking areas of radius 5km out to approximately 300 km. The 2% duty cycle would mitigate the potential for masking; i.e., 98% of the time a shark would be able to percieve prey through low frequency sounds, and effective masking would occur for environmental sounds shorter than the 20 min ATOC transmission period, that happened to fall within that 20 min transmission window.

The greatest potential impact would be anticipated among those animals that have exhibited the capability to dive as deep as the ATOC source and that do, or might possibly, hear low frequency sounds well. As indicated above, this group includes the sperm whale and the leatherback sea turtle. At deep sound channel depths (800-1000 m off the north Kauai coast) the ocean is somewhat quieter, with average ambient noise levels 2-3 dB below those at the surface. When animals capable of detecting low frequency sound are at these depths during the 2% of the time that the source is transmitting, it could be audible (at approximately 91 dB received level) to an estimated range of up to 500 km.

Effects of low frequency sound on other species of marine animals, including seabirds, plankton, and invertebrates, are expected to range from uncertain to nonexistent. Effects on growth rates of one species of shrimp have been observed in laboratory experiments (where the sound was continuous and the shrimp were contained within physical boundaries). However, the zone within which this impact might occur as a result of source transmissions would be expected to be very small, and would not be expected to affect a significant portion of the shrimp population or, indirectly, the species (including baleen whales) that prey on shrimp.

In sum, the potential effects of ATOC sounds on marine animals are an important concern, and an accurate assessment of the scale of the possible impacts is required. Based on the data currently available, the greatest possible concern should be for sperm whales, leatherback sea turtles and sharks. However, adverse impacts are not anticipated.

OTHER POTENTIAL EFFECTS

Apart from potential acoustic effects on marine organisms, the environmental impacts of the proposed project are very minor, as summarized below.

Physical Effects

The ATOC project's physical facilities are relatively small in scope and generally minimal, including a sound source comparable in size to a large water heater, mounted in a tripod frame 3.7 m (11 ft) high. A 2.5 cm (1 in) diameter power cable, 51.5 km (27.8 nm) long, would connect the source to an existing cable seaward of Barking Sands. No trenching or similar alteration of the seafloor would occur, and all of the facilities would be removable. The direct physical impacts of the project are, therefore, negligible. The source sounds would add to the ambient noise levels in the vicinity of the sound source during the 2-8% of the time it would be operating.

Socioeconomic Effects

Socioeconomic effects are likewise considered to range from minor to nonexistent. No significant impacts are anticipated in the areas of commercial, recreational or potential fisheries, mariculture activities, shipping, military usage, mineral or energy development, cultural and historical areas, recreational activities and tourism, or other socioeconomic areas. Further, a Kauai Citizen's Advisory Group (CAG) would be formed. Before the 1994 Hawaii public hearings on the proposed project, the MMRP Director and senior staff had several meetings with a number of concerned Kauai citizen's groups. During the course of these meetings, the concept of a CAG was conceived. A number of people who attended those meetings are promising candidates for the CAG. The goal would be to have representation from the following Kauai organizations:

- Local fishermen
- Commercial water users (e.g., zodiac boat tour operators)
- Native Hawaiian groups (sovereignty movement)
- Chamber of Commerce
- Local education (e.g., Kauai Community College)
- Local government (e.g., Mayor's office)

Aditional representation from other pertinent Kauai organizations would be welcomed, with the objective of having approximately ten representatives on the CAG. Immediately upon receipt of the necessary permits and authorizations to conduct the MMRP, contact would be made with these organizations, requesting that they nominate a primary representative and an alternate to the CAG. A charter would be drafted and approved by a majority of the CAG members at the outset to ensure this effort would engender productive and responsive interactions.

Consistency with Plans and Policies; Other Impacts

The ATOC project and its physical facilities, and the MMRP, are analyzed in relation to applicable plans and policies in Section 5 of this EIS. It is believed that ATOC and the MMRP are consistent with all such plans and policies, including the Hawaii Coastal Zone Management Program, the Hawaii Ocean Resources Management Plan, and the Final Humpback Whale Recovery Plan.

No other potential impacts of the project are of significant concern.

Significance of Potential Impacts

As stated above, this EIS is intended to comply with both NEPA and HEPA. According to HEPA (Hawaii Department of Health's Administrative Rules, Title 11, Chapter 200, Section 11-200-12), an action shall be determined to have a significant impact on the environment if it meets any one of the following criteria:

- Involves a loss or destruction of any natural or cultural resource;
- Curtails the range of beneficial uses of the environment;
- Conflicts with the State's long-term goals or guidelines as expressed in Chapter 344, HRS;
- Substantially affects the economic or social welfare of the community or state;
- Substantially affects public health;
- Involves substantial secondary effects. such as population changes or infrastructure demands;
- Involves a substantial degradation of environmental quality;
- Is individually limited but cumulatively has considerable effect on the environment, or involves a commitment to larger actions;
- Substantially affects a rare, threatened or endangered species or its habitat;
- Detrimentally affects air or water quality or ambient noise levels; or
- Affects an environmentally sensitive area, such as a flood plain, tsunami zone, erosion-prone area, geologically hazardous land, estuary, freshwater area, or coastal waters.

Measured by these criteria, potential impacts from the proposed ATOC source are deemed less than significant, based on the application of 23 mitigation measures. No other potential impacts are significant, based on commonly-applied standards articulated in Section 4.

The conclusions in this EIS regarding the significance of potential impacts are not intended to constrain decisions under other regulatory programs, although those conclusions may provide information relevant to other programs. For example, a "taking" by "harassment" of marine mammals requiring a permit from NMFS can still occur despite "less than significant" impacts of that harassment (as defined by HEPA). Also, the designation of a potential impact as less than significant is not intended to imply that it is unimportant or not worthy of concern. This is demonstrated by the adoption of mitigation measures for several less than significant impacts, even though HEPA does not require mitigation of such impacts.

ALTERNATIVES TO THE PROPOSED ACTION

A number of alternatives were evaluated in the development of the ATOC project proposal. The alternatives presented in this EIS include several different scientific approaches to the global warming problem, alternative technologies for acoustic thermometry, and alternate acoustic source sites. Some of the alternatives identified by the preparers or requested by the public are, in fact, elements of the proposed project and are not analyzed separately. Several other alternatives were found not to meet project objectives and were eliminated from detailed analysis.

The alternatives considered include: 1) the proposed action; 2) no action; 3) alternate project sites (four such sites are screened; including sites off the coast of Kauai, Midway Island, Johnston Atoll, and the Aleutian Islands); 4) moored autonomous sources; 5) restricted source transmission times; 6) modified source operational characteristics; 7) global climate models; 8) satellite sensors for sea surface temperature measurements; 9) satellite sensors for sea level measurements; 10) oceanographic point sensors (measurements using conventional thermometers); 11) autonomous polar hydrophones; and 12) dual site experiment (alternative MMRP techniques--mobile playback experiments).

Of the twelve alternatives considered, the proposed action (Kauai), no action, one alternate site (Johnston Atoll), and moored autonomous sources were selected for detailed consideration.

Generally speaking, all of the alternative scientific methods for addressing the global warming problem are either included in the project as proposed, or would not meet project objectives. For example, the use of global climate models is an integral part of the project. Satellite measurements of sea surface temperature and sea level are also important sources of information regarding global warming, but do not provide information comparable to that expected from ATOC. Oceanographic point sensors are also useful, but are limited due to the relatively small number of measurements that are practicable. Similarly, alternative acoustic thermometry techniques are included in the project proposal to the extent feasible. For example, this project already has source operational characteristics optimized for low transmission intensities and impacts; restricted (seasonal) source transmission times would not support MMRP or acoustic thermometry objectives. Also, mobile playback experiments are planned as an adjunct to the MMRP (see Appendix C).

Several constraints are faced in siting an acoustic source for ATOC purposes. A suitable source site must, among other factors: 1) be at or near the deep sound channel depth; 2) have downward slopes in the direction of receiving stations; 3) lack acoustic obstructions (seamounts, shoals, etc.) in the direction of those receivers; and 4) be reasonably close to shore (to minimize cable lengths and other logistical problems). Also, since a goal of these experiments is to evaluate the potential impacts of low frequency sound on marine animals, sufficient populations should be present close enough to shore so that they can be studied. Very few sites meet all of these criteria and none nearly as well as the proposed Kauai (and preferred California site [Sur Ridge]).

The ATOC project's screening of potential source sites was comprehensive. First, an ocean basin was selected for the proposal. In making this selection, the northern hemisphere was preferred due to the relatively large number of subsea listening systems already in place; these were installed during the cold war at a cost of approximately $20 billion, and could not practicably be replicated elsewhere. The Pacific was preferred over the Atlantic because the mid-Atlantic ridge is a potential acoustic barrier (and possibly an acoustic mirror) at sound channel depths. Central and eastern Pacific locations were preferred given the proximity to U.S. research institutions and the relative abundance of U.S. possessions, including the mainland U.S. From that point the proposal evolved to locate a source in the mid-Pacific. The north shore of Kauai is the only area that combines favorable logistics with good acoustic views to the Aleutian Islands. The specific site proposed north of Kauai is the location furthest from shore, at sound channel depth.

A moored autonomous source is one which is not attached to shore-based power by cables but is free-standing, powered by large battery assemblies, moored to the ocean bottom with weights, and buoyed up by floats at the correct ocean depth. The principal advantage of moored autonomous sources is the increased flexibility in siting opportunities that they present. On the other hand, most moored autonomous source locations would probably be some distance from shore, and would create severe logistical problems for any marine mammal research program. To date, there have been no sources designed for autonomous operation that efficiently operate at frequencies as low as 75 Hz, or have been proven to function at pressures found at 750-1000 m deep in the ocean. In addition, since a moored source would sway in the horizontal plane (due to current motion), and accurate location is critical for acoustic thermometry, equipment would have to be included for real-time tracking of the source's position within a few feet. Such equipment is available for other applications, but has not yet been adapted for this use. In addition, the power requirements of a moored autonomous source are greater than other oceanographic applications and large battery packs (probably lithium) would be required. As a result, this alternative cannot be considered the optimum choice at this time. Nonetheless, due to its potential future applicability, this alternative is analyzed in detail in this EIS.

Comparison of Alternatives

The Kauai site best meets the project objectives for both the ATOC feasibility demonstration and the MMRP. The Johnston Atoll site would be a relatively poor location for the MMRP due to its distance from shore, as well as the low concentrations of marine mammals of interest. Johnston Atoll also has poor acoustic views. Installation of moored autonomous sources would also require the development of new technology and resolution of a number of engineering problems.

The comparative biological impacts of the alternate source sites would depend upon the relative abundance of sensitive animals at the respective locations. For the most part, these differences would be a matter of degree, with no site offering clear advantages from the standpoint of all species. The no action alternative would have no impacts on marine animals, but would not achieve the project objectives.

All of the alternatives would have comparable physical impacts, with the exception of the no action alternative that would have no physical impacts, and the moored autonomous source alternative that would not involve a cable installation, but which would have minor potential impacts from the use, disposal, and potential leakage of toxic battery fluids. Similarly, all of the alternatives would have comparable socioeconomic effects, except for the no action alternative that would have none of the beneficial or adverse impacts of the proposed project.

MITIGATION MEASURES

This EIS has identified mitigation measures that would be applied to the proposed project in two ways. First, beneficial features of several alternatives, that would mitigate the potential effects of ATOC subsea sounds on marine animals, have been identified and incorporated into the project as proposed. These mitigation measures derived from the alternatives are numbered in sequence with an "A" prefix, as follows:

Mitigation Measure A-1: A dedicated MMRP Pilot Study will precede ATOC feasibility operations as described in detail in Section 2.2.1 and Appendix C.

Mitigation Measure A-2: ATOC sound sources would utilize frequencies anticipated to have minimal adverse impacts on species that may be exposed to their acoustic output (i.e., based on available information, either a higher or lower frequency might be expected to result in increased potential adverse impacts).

Mitigation Measure A-3: ATOC sound sources would operate at the minimum power level necessary to support MMRP objectives and feasibility operations.

Mitigation Measure A-4: The ATOC project would continue to study source waveforms and transmission lengths that may facilitate long-range detection of the source sounds which, in turn, may permit lower source intensities than would otherwise be required.

Mitigation Measure A-5: ATOC sound sources would operate at the minimum duty cycle necessary to support MMRP objectives and feasibility operations.

Second, other mitigation measures are identified as follows:

Mitigation Measure 1-1: For the Johnston Atoll alternative, the portions of the ATOC cable and any protective casing in the nearshore area and surf zone would be designed to minimize the potential for adverse impacts.

Mitigation Measure 1-2: ATOC facilities would be removed at the end of the experiment, to the extent economically and practicably feasible.

Mitigation Measure 2-1: The duty cycle and power levels of the ATOC source would be adjusted to the minimum necessary to support research objectives, and the source would be shut down if any of the acute or short-term responses in Table C-1 are observed in relation to source transmissions.

Mitigation Measure 2-2: The ATOC project would coordinate with other oceanographic and acoustic research efforts, U.S. Navy activities, and the commercial fishing industry, to ensure that scheduling and operational conflicts are avoided.

Mitigation Measure 3-1: A Marine Mammal Research Program (MMRP) will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential physical auditory impacts on mysticetes, a goal of the MMRP will be to validate the assumptions regarding population distribution and diving behavior, which form the basis for predicting the potential for effects from the ATOC sound source.

Mitigation Measure 4-1: As provided in mitigation measure 2-1, the duty cycle and power levels of the ATOC source would be adjusted to the minimum necessary to support research objectives, so that potential impacts to mysticetes would be minimized.

Mitigation Measure 4-2: As provided in mitigation measure 3-1, a MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential impacts on mysticetes, a goal of the MMRP will be to identify the nature, frequency, and significance of any responses to ATOC source transmissions.

Mitigation Measure 5-1: As provided in mitigation measure 2-1, the duty cycle and power levels of the ATOC source would be adjusted to the minimum necessary to support research objectives, so that potential long-term impacts to mysticetes would be minimized.

Mitigation Measure 5-2: As provided in mitigation measure 3-1, a MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential long-term impacts on mysticetes, a goal of the MMRP will be to identify the nature, frequency, and significance of any long-term changes due to ATOC source transmissions (via comparison of animal distribution data before, during, and after source transmission periods over a two-year period).

Mitigation Measure 6-1: A MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential physical auditory impacts on odontocetes, a goal of the MMRP will be to validate the assumptions regarding population distribution, abundance and diving behavior of sperm whales, which form the basis for predicting the potential for effects from the ATOC sound source.

Mitigation Measure 7-1: A MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential physical auditory impacts on the one pinniped species endemic to the Hawaiian Islands, the Hawaiian monk seal, a goal of the MMRP would be to validate the assumptions regarding population distribution in the study area (via aerial visual surveys), which form the basis for predicting the likelihood of potential impacts due to the ATOC source transmissions.

Mitigation Measure 8-1: The MMRP would support field research to attempt the collection of auditory and/or behavioral observations on leatherback sea turtles.

Mitigation Measure 9-1: The MMRP would incorporate into its research protocol the goal of assessing whether acoustic transmissions could potentially cause sea turtles to spend more time than normal at the sea surface.

Mitigation Measure 9-2: The MMRP would incorporate into its research protocol, the goal of assessing whether acoustic transmissions could potentially cause leatherbacks and other sea turtle species to avoid the ATOC source area.

Mitigation Measure 10-1: The MMRP would monitor fish stock assessments (via Western Pacific Regional Fishery Management Council catch-block landing data; LTPY, CPY, and RAY data from NMFS; and interaction with the Kauai CAG and local fishermen) to attempt evaluation of the potential for increased mortality and predation on fish, in relation to ATOC source sounds.

Mitigation Measure 11-1: The MMRP would monitor fish stock assessments (via Western Pacific Regional Fishery Management Council catch-block landing data; LTPY, CPY, and RAY data from NMFS; and interaction with the Kauai CAG and local fishermen) to attempt evaluation of the potential for impacts to fish, particularly sharks, in relation to ATOC source sounds.

Mitigation Measure 12-1: Vessel and aircraft traffic would be kept to a minimum, consistent with the requirements of the MMRP protocols and ATOC program requirements. Where possible, trips would be consolidated or other measures taken to reduce the aircraft and vessel traffic levels resulting from the project.

Mitigation Measure 13-1: All ATOC/MMRP vessels and aircraft would be equipped with required air pollution controls.

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1 INTRODUCTION, PURPOSE AND NEED FOR ACTION

This Environmental Impact Statement (EIS) evaluates the potential impact of a low frequency sound source proposed to be installed by the University of California, San Diego, Scripps Institution of Oceanography (Scripps) off the north shore of Kauai, Hawaii, as a part of the Acoustic Thermometry of Ocean Climate (ATOC) project. It also evaluates the potential impacts of marine mammal observation activities proposed to be carried out as part of the ATOC program.

Under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), permits are required for activities that would "harass" marine mammals, defined further under the MMPA as "any act of pursuit, torment, or annoyance which: 1) has the potential to injure a marine mammal or marine mammal stock in the wild; or 2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding or sheltering." Activities falling under the first definition are termed Level A harassment, while those encompassed by the second are called Level B harassment. Since previous studies on marine mammals have observed possible changes in behavior, such as approach to or avoidance of the sound source or change in habitat utilization, in response to nearby subsea sounds at intensities comparable to the proposed sound source, the ATOC project has been determined to be subject to this permitting program.

Three permit options potentially are available in this situation. First, permits can be issued for *bona fide* research, defined under the 1994 MMPA Amendments as "scientific research on marine mammals, the results of which -- (a) likely would be accepted for publication in a referred scientific journal; (b) are likely to contribute to the basic knowledge of marine mammal biology or ecology; or (c) are likely to identify, evaluate, or resolve conservation problems." Second, authorizations can be issued for the harassment of "small numbers" of marine mammals "incidental" to any other lawful activity. Third, a waiver can be requested of the MMPA's moratorium on taking.

In 1993, Scripps was informed by the National Marine Fisheries Service, Office of Protected Resources (NMFS) that a scientific research permit (SRP), rather than an incidental take authorization would be the preferred approach. This choice was guided, in part, by NMFS's concern that available information was insufficient to make the findings necessary to issue a small take exemption and, that additional scientific research to evaluate the potential impacts of low frequency ATOC source transmissions on marine mammals is needed.

As a result, and in compliance with MMPA and ESA guidelines, Scripps submitted an application for a scientific research permit (SRP) to NMFS to evaluate any potential effects on marine mammals of the ATOC low frequency sound transmissions off the north shore of Kauai, Hawaii via a Marine Mammal Research Program (MMRP). A revised application is being submitted in conjunction with this Final EIS, which specifies a MMRP Pilot Study starting in the fall of 1995.

Under Chapter 190D of the Hawaii Revised Statutes, a permit is required for use of lands in the state's Conservation District. Because the ATOC sound source and cable are on submerged lands that are part of the Conservation District, Scripps has applied to the Hawaii Department of Land and Natural Resources (DLNR) for a Conservation District Use Permit.

The purpose of this EIS is to identify any potentially significant environmental effects associated with the proposed project, to identify alternatives to the proposed project, and to discuss measures which can be incorporated into the project to mitigate or avoid potentially significant impacts. This EIS has been prepared to facilitate NMFS's and DLNR's consideration of Scripps' applications and to provide a public forum for disclosure and discussion of the potential environmental impacts of the proposed project. It also is intended to augment other environmental reviews required for the project, including consultation under Section 7 of the Endangered Species Act and review of the project by the State of Hawaii (Office of State Planning) under the federal Coastal Zone Management Act, the Hawaii Department of Health, and other state and federal agencies.

This project is proposed to be carried out using two separate acoustic sources; the one discussed in this document, to be located off the north shore of Kauai, Hawaii, and a second source to be located off central California. Because of the differences between the two installations, in terms of research programs as well as the environmental settings, NMFS determined early in the permitting process that separate environmental documentation should be prepared.

A joint federal/state Environmental Impact Statement/Environmental Impact Report (EIS/EIR) has been prepared for the California ATOC acoustic source pursuant to the requirements of both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). This document, known as California ATOC/MMRP Final Environmental Impact Statement/Environmental Impact Report was released for public review on May 5, 1995, and is hereby incorporated by reference into this EIS. An Environmental Assessment (EA) was prepared for the ATOC Acoustic Engineering Test (AET), which was accomplished in November 1994 and is incorporated by reference into this FEIS. The Draft EIS for the Kauai ATOC Project and its associated MMRP is also incorporated by reference into this FEIS. Copies of the California Final EIS/EIR, the AET EA, the Kauai Draft EIS and the Kauai Final EIS will be available for public review at the following locations:

1. National Marine Fisheries Service
   Office of Protected Resources
   1330 East-West Highway
   Silver Spring, Maryland 20910

2. Department of Land & Natural Resources
   Office of Conservation & Environ. Affairs
   1151 Punchbowl
   Honolulu, HI 96813

3. Office of Environmental Quality Control
   220 South King Street, Fourth Floor
   Honolulu, HI 96813

4. University of California, San Diego
   University Library
   9500 Gilman Drive
   La Jolla, CA 92093

5. State Main Library
   478 South King Street
   Honolulu, HI 96813

6. University of Hawaii
   Hamilton Library
   2550 The Mall
   Honolulu, HI 96822

7. Kauai Regional Library
   4344 Hardy Street
   Lihue, HI 96766

8. Koloa Community School Library
   P.O. Box B
   Koloa, HI 96756

9. Kapaa Public Library
   1464 Kuhio Highway
   Kapaa, HI 96746

10. Hanapepe Public Library
    P.O. Box B
    Hanapepe, HI 96716

11. Molokai Public Library
    P.O. Box 395
    Kaunakakai, HI 96748

12. Lanai Community School Library
    P.O. Box A-149
    Lanai, HI 96763

13. Kahului Regional Library
    90 School St.
    Kahului, HI 96732

14. Hilo Regional Library
    P.O. Box 647
    Hilo, HI 96721

15. San Francisco Public Library
    Civic Center
    San Francisco, CA 94102

16. Los Angeles Public Library
    Central Library
    630 West 5th Street
    Los Angeles, CA 90071

17. Monterey Public Library
    625 Pacific Street
    Monterey, CA 93940

18. Santa Cruz City/County Library System
    224 Church Street
    Santa Cruz, CA 95060

This EIS specifically addresses only the Hawaii portion of the ATOC project. The organization of this EIS is as follows: Section 1 contains a description of the proposed project and its associated MMRP, also briefly describing applicable regulatory requirements and the scoping process that supported the development of this EIS. Section 2 describes twelve potential alternatives to the project on an initial screening level, selecting four of those alternatives for detailed environmental analysis -- the proposed project mid-Pacific source location (north of Haena Point, Kauai), no action, one alternative source location (Johnston Atoll), and an alternative technology (moored autonomous sources). Section 3 describes the environmental setting, focusing on habitat values important to marine mammals, sea turtles, sea birds, fishes and invertebrates, but also discussing other areas of concern expressed by the public during the scoping process. Section 4 evaluates the potential environmental impacts of the proposed action and alternatives, again focusing on habitat questions but also evaluating the full range of potential impacts. Section 5 reviews project consistency with applicable requirements. Section 6 includes analysis of a number of additional issues to be considered under NEPA, and other regulatory programs. Section 7 lists the individuals involved in preparing this document and Section 8 includes the EIS Circulation List.

1.1 THE ATOC FEASIBILITY PROJECT

This subsection presents some background on the global climate change question that project seeks to address, an evaluation of the rationale and approach proposed for the Marine Mammal Research Program, a description of how the acoustic thermometry system is expected to work, and a description of the specific facilities and activities proposed for the project in Kauai.

1.1.1 INTRODUCTION TO THE GLOBAL CLIMATE CHANGE PROBLEM AND ATOC'S ROLE IN ADDRESSING THAT PROBLEM

During the last few decades the problem of global climate change has received intense international attention. It is now known that atmospheric concentrations of a number of gases, particularly carbon dioxide, methane, and freons, are steadily increasing due to human activities. For example, carbon dioxide is produced by the burning of fossil and other fuels. The clearing of tropical rainforests also has been identified as a contributor to carbon dioxide buildup in the atmosphere. Farming activities increase methane production. Freons are widely used in air conditioning equipment and manufacturing processes and, until recently, had been routinely released into the atmosphere during the maintenance and disposal of these systems.

It is also known that these gases tend to trap heat within the atmosphere -- the "greenhouse effect." Whether or not the increasing concentrations of greenhouse gases will lead to global warming is a complex and controversial question. It has been argued that increasing levels of carbon dioxide will simply stimulate plant growth which, in turn, will remove the carbon from the atmosphere. Similarly, it is suggested that temperatures will be moderated by the ocean serving as a "heat sink" or that short-term increases in temperature will result in increased cloud cover which will reflect sunlight, reduce temperatures, and thereby counteract the effect of these emissions.

Data collected from tide gauges over the last century have shown increases in the average sea level of about 0.10 to 0.20 cm/yr, the amount many scientists expect due to global warming. However, there are relatively few tide gauges around the globe, and their accuracy often comes into question. Now, a U.S.-French oceanography satellite, Topography Experiment/Poseidon (TOPEX/Poseidon), using advanced altimeter measurements of sea level, has produced similar results, as announced at the December, 1994 meeting of the American Geophysical Union. Preliminary data taken from December 1992 to September 1994 indicate a rise of approximately 0.31 cm/yr (NASA, 1994). NASA stated that such an increase can be caused by thermal expansion of the oceans, and melting of glaciers and the polar ice caps -- a long-term rise in mean sea level would support the existence of global warming.

In consonance with the sea level measurements via tide gauges and satellites, global climate change discussions are often based on projections primarily derived by complex computer models. In part, these models attempt to reflect the fact that the atmosphere and ocean form a combined system, interacting to determine the earth's weather and climate. Since the oceans are the earth's major reservoir of heat, as well as an important depository of carbon dioxide, they play a pivotal role in moderating or otherwise affecting global climate change.

Computer models of global warming due to increasing greenhouse gases predict complicated large-scale patterns of warming and, in some regions, cooling of the atmosphere and ocean. Some predicted changes are very severe; one model predicts that the ventilation, or circulation, of the deep ocean will cease, with severe consequences to marine life.

However, the time scales and the specific global consequences on climate predicted by these models have been criticized as inaccurate and oversimplified. Therefore, they have had limited impact on governmental decisions to take action to curb emissions of greenhouse gases. A principal shortcoming of these models results from the fact that, in several critical areas, they must rely upon assumptions about, rather than actual measurements of, ocean "weather." Global atmospheric climate changes cannot be predicted without fully understanding global ocean processes. Yet, to date, there are no large-scale observations of ocean temperatures to compare with and verify the predictions of existing climate models. There is important need for model predictions to be tested against observations, if the models are to serve as a persuasive basis for policy formulation.

The proposed ATOC project is a demonstration or "proof of concept" phase, with the goal of testing the acoustic thermometry concept. Following this initial demonstration period, any future facilities or operations would be subject to additional environmental review and authorization. The lessons learned from the demonstration phase would support facets of future global climate change research planning, such as whether the program will proceed; and if so, would address where facilities would be located, equipment design, sound levels, mitigation measures, etc. Since it is not presently known what will be learned from the demonstration phase, the particulars of any future activities can only be speculated on at this time.

1.1.2 THE MARINE MAMMAL RESEARCH PROGRAM

The Acoustic Thermometry of Ocean Climate program recognizes a need to evaluate the potential effects of the proposed source transmissions on marine animals, in particular marine mammals and sea turtles. It is known, for example, that some large whales vocalize (and presumably can hear well) in frequency ranges similar to those to be used by the ATOC system. However, very little is known about the effects of low frequency sound on marine animals, particularly marine mammals and sea turtles.

In response to the question of potential effects, a Marine Mammal Research Program (MMRP), led by Dr. Christopher W. Clark of Cornell University's Bioacoustic Research Program, has been established as an integral part of the ATOC project. The MMRP would investigate the potential impact of the low frequency sound sources on marine mammals and sea turtles at both the California and Hawaii source sites. Dr. Clark heads the research in Hawaii and Dr. Daniel P. Costa of the University of California, Santa Cruz (Long Marine Laboratory), leads the California research. The MMRP recognizes that the available data on this question are sparse and has designed research protocols to broaden the information base. In Hawaii, the MMRP has been gathering baseline data for two seasons at the location of the proposed source site.

The University of Hawaii (Rappa et al., 1994) prepared for NOAA the publication A Site Characterization Study for the Hawaiian Islands Humpback Whale National Marine Sanctuary, in which they acknowledged the expected benefits of the proposed action: "Projects such as the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program .... promise to expand our knowledge of the effects of low frequency sound on humpback whales in particular."

Initially, the MMRP will conduct a Pilot Study to evaluate potential significant effects on marine animals, particularly marine mammals and sea turtles, before initiating ATOC climate-related operations. This would entail manipulating the signal strength (power levels) and duty cycle (repetition rate) of the source for a period of 6-10 months. Results would be evaluated on a near real-time basis throughout the Pilot Study such that modifications to the sound usage based on initial duty cycles could be implimented and tested during the Pilot Study. A quicklook evaluation available 30 days after conclusion of the Pilot Study would be reviewed by ARPA, NMFS, the MMRP Advisory Board (MMRP AB), the Marine Mammal Commission (MMC), the Marine Mammal Center (TMMC), and the proposed Kauai Community Advisory Group. The quicklook would verify whether or not any acute or short-term responses (Table C-1) could be attributed to ATOC sound transmissions. Research would continue (after the MMRP Pilot Study) only if no such adverse effects were observed. NMFS has the ultimate authority for allowing the research to proceed.

Following sucessful completion of the MMRP Pilot Study, regularly scheduled ATOC feasibility operations would commence during which the MMRP research phase would continue throughout. Transmissions would occur on one out of every four days. Transmissions on that day would last for 20 min every 4 hrs, the minimum time necessary to study the potential effects on marine mammals and to collect climate-related data. This equates to a duty cycle of 2% (the source will be silent 98% of the time). About six months after the end of the MMRP Pilot Study and after release of the Final Pilot Study Report, two months of transmissions at an 8% duty cycle (20 min transmissions every 4 hrs on every day) would be conducted to investigate the effects of tides and other high frequency ocean fluctuations on the acoustic transmissions. Following the two-month ocean effects investigation, the schedule would resume transmissions at the 2% duty cycle. Table 1.1.2-1 displays in a graphic form this sequencing and interrelationship of the components of the program. Studies of the potential effects of low frequency source transmissions on marine mammals and sea turtles would be conducted throughout all of these sequences.

A detailed description of the MMRP Pilot Study Research Protocol is included in Appendix C.

ACTIVITY	TIME PERIOD (duration)	ACTIVITIES INVOLVED	SL/DUTY CYCLE
1. MMRP Preliminary Baseline Data Collection (No source transmissions)	Jan 93 - Apr 95 (Approx.) (3 field seasons 12 months total approx.)	• Aerial Surveys. • Shipboard visual and acoustic surveys. • Shipboard behavioral observation and Photo ID. • Small boat-based behavioral observation. • Shore-based observations.	0/0
2. MMRP Pilot Study; including near real-time data processing and analysis	Aug/Sep 95 - Feb/Mar 96 (approx.) (6 months approx.)	• MMRP Research Team (MRT) operates source at varying intensities (≤ 195 dB source level) and duty cycles (≤ 8%) to assess the potential for any impacts on marine animals. • Continue activities from baseline data collection phase. • HLA-based acoustic detection of mysticetes. • Cetacean playback studies (humpback whales)	185-195 dB/ 2-8%
3. MMRP Pilot Study Quicklook Report	Apr/May 96 (approx.)	• MRT reports on preliminary results from Pilot Study to all concerned (ARPA, Scripps, NMFS, MMC, PRSRG, TMMC, Kauai CAG, etc.). • Data used as basis for authorization to start follow-on ATOC feasibility ops and MMRP research.	N/A
4. MMRP Research	May/Jun - Nov 96 (approx.) (6 months approx.)	• MMRP continue activities from baseline data collection phase, as scheduled. • Assuming positive results from Pilot Study Quicklook Report, ATOC feasibility ops proceed at ≤ 195 dB source level and 2% duty cycle (6 transmissions/day, every 4th day).[1]	195 dB/ 2%
5. MMRP Pilot Study Final Report	Nov 96 (approx.)	• To be used as a final determination for continuation and configuration of ATOC feasibility ops and MMRP activities.	N/A
6. MMRP Research	Nov 96 - May 97 (approx.) (6 months approx.)	• MMRP and ATOC feasibility ops continue in parallel. • Assuming positive results from Final Pilot Study Report, duty cycle increased to 8% (6 transmissions/day every day) for 2 month study of tidal and ocean high freq. fluctuation effects.[1] • After 2-month investigation, ATOC feasibility ops revert to 2% duty cycle (6 transmissions/day every 4th day) for duration.	195 dB/ 2-8%

[1] If Pilot study quicklook/final report results are negative, ATOC feasibility operations would not commence until the issues raised by the report had been resolved.

Table 1.1.2-1 MMRP and ATOC program elements and sequencing (proposed Kauai site).

1.1.3 THE ACOUSTIC THERMOMETRY PROGRAM

The basic idea of ATOC is simple. Sound travels faster in warm water than in cold water. The travel time of a sound signal from a source near Hawaii to a receiver near California, for example, will decrease if the intervening ocean warms up, and will increase if the ocean cools down. The velocity of sound in the sea also increases with an increase in salinity, but in the open ocean deepwater, salinity normally has only a small effect in the velocity (Urick, 1983). The travel time is a direct measure of the large-scale average temperature between the source and receiver. The information obtained is similar to that which would be obtained for the atmosphere by averaging data from the many thousands of land-based weather stations that exist.

The Hawaii-based source would be used to transmit low frequency, digitally coded sounds across the North Pacific ocean basin to receiving stations offshore Alaska, Washington, Oregon, California, and Guam. By measuring the travel time of these sounds, it is anticipated that basin-scale measurements of ocean temperatures can be obtained that will provide important empirical information for studying global climate questions, particularly global warming due to the greenhouse effect.

The proposed system takes advantage of an acoustic waveguide deep within the ocean that carries sounds over very long distances. This waveguide, known as the "sound channel" or sound frequency and ranging (SOFAR) channel, is centered on the ocean depth where the speed of sound is at a minimum. Above the sound channel axis, sound travels faster because the water is warmer; below, sound travels faster because the pressures are greater. Acoustic energy within the sound channel that would otherwise spread to higher or lower depths is refracted (bent) back into the sound channel by this difference in speeds. The net effect is that the sound channel serves as a conduit that transmits sounds very efficiently over long distances. This effect also tends to limit sounds that are trapped in the channel from being heard well at depths outside of the channel.

The depth of the sound channel depends upon the location of the sound speed minimum, which varies in depth based upon the temperature profile at a given location. Since surface temperatures tend to decrease toward the poles, the sound channel generally is deepest in tropical waters and shallowest in Arctic waters. Typical depths of the sound channel in the Gulf of Alaska, for example, are 100 to 200 m, but in warmer areas it is much deeper, on the order of 750 to 1000 m. On the north shore of Kauai, the sound channel axis is nominally at 800 m, which generally corresponds to the depth at the proposed ATOC source location.

Previous experiments have shown the feasibility of measuring ocean temperature by transmitting signals between sources and receivers separated by 1000-2000 km. ATOC is designed to demonstrate that acoustic thermometry can be used to determine ocean climate variability by extending the range to that needed to monitor ocean temperature over entire ocean basins. The initial phase involves the development and installation of affordable acoustic hardware, which would extend these ranges to include the entire North Pacific basin. To do so, two low frequency sound sources are planned for the North Pacific, one north of Kauai and one west of central California. Special hydrophone receiver arrays would be installed in the South Pacific, near Rarotonga, and in the mid-Pacific, approximately half way between central California and Rarotonga. In addition, existing U.S. Navy seabed receivers in the North Pacific would be used, thereby increasing the network of receiving sites in the most cost-effective way. Special receiving equipment installed at the U.S. Navy facilities would allow the existing Navy receivers to detect and record the coded sound transmissions. The proposed fixed network of sources and receivers around the Pacific Ocean is illustrated in Figure 1.1.3-1. The network would be complemented by up to ten drifting receivers that would be deployed along selected transmission paths under the Global Acoustic Mapping of Ocean Temperature (GAMOT) program. Together ATOC and GAMOT comprise the Strategic Environmental Research and Development Program's (SERDP) Acoustic Monitoring of Global Ocean Climate Program.

The sounds to be produced by the acoustic sources are digitally coded, low frequency signals comparable to the lowest notes of a cello. The same digital sequences are repeated a number of times and then combined at the receiving end. The receiving stations would use advanced digital processing techniques, similar to those used in retrieving data from deep space probes, to detect the source signals after they have traveled over long distances. These techniques allow a signal to be detected below the ambient background noise, thereby permitting use of a lower volume at the sound source.

The primary objectives of the proposed MMRP are listed below in section 1.2. The research project plans to use two acoustic sources each located at a depth of approximately 850 m. Acoustic signals would be transmitted at 75 Hz center frequency (Figure 1.1.3-2), which is near the middle of the spectrum of deep ocean ambient shipping noise, and has a nominal bandwidth of 35 Hz. Peak power output of the source at 75 Hz will be 180 dB; total power, integrated across the entire 35 Hz bandwidth will be 195 dB, which is equivalent to 260 watts. Table 1.1.3-1 shows how the source sound level compares with other natural and human-made oceanic noises.

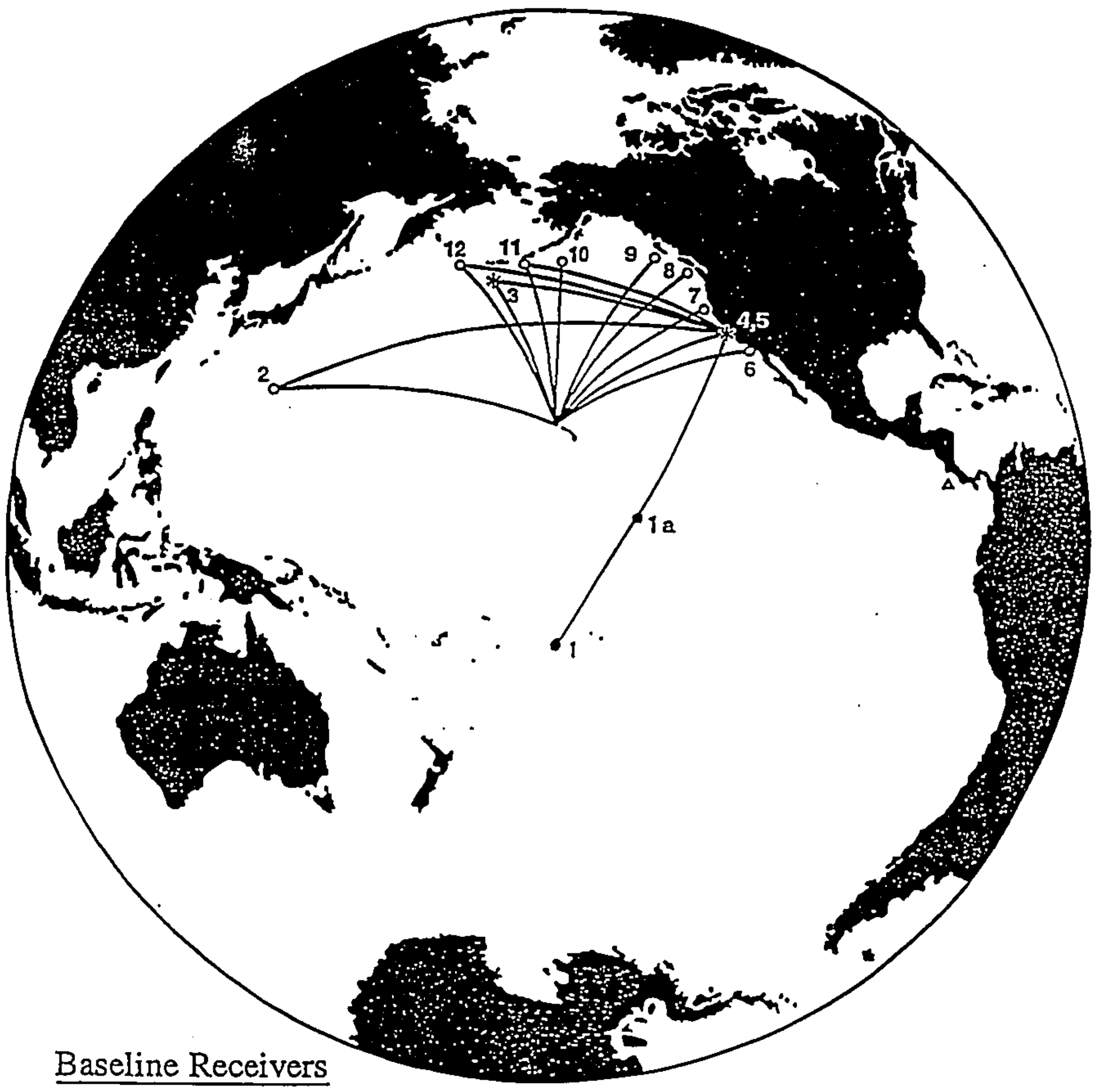
1.1.4 FUNDAMENTALS OF SUBSEA SOUND MEASUREMENTS

An understanding of the conventions of sound measurements is important for evaluating the various decibel values presented in this EIS. This subsection summarizes the factors most directly pertinent to the analysis in this document.

The decibel scale used for sound measurements is a logarithmic scale of acoustic pressure. All decibel measurements state the ratio between a measured pressure value and a reference pressure value. The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power -- 20 dB is a 100-fold increase, 30 dB is a 1000-fold increase. A 60 dB difference therefore represents a million-fold power difference.

Comparing decibel values for various noise sources must be done carefully, since those values do not always represent equivalent information. It is particularly important to distinguish "spectral" from "broadband" measurements, and to distinguish "water standard" from "air standard" values.

Spectral values represent the power levels within one Hertz (cycle per second) "slices" of an acoustic frequency spectrum; Figure 1.1.3-2 is an example of such a measurement, showing the



Baseline Receivers

o Navy (notional locations)

1./1a. Rarotonga (Autonomous)
2. Guam (N)
3. West Pac (Autonomous)
4. Pioneer Seamount
5. Pt. Sur (N)
6-9. East Pac (N)
10-12. North Pac (N)

Figure 1.1.3-1 ATOC baseline network

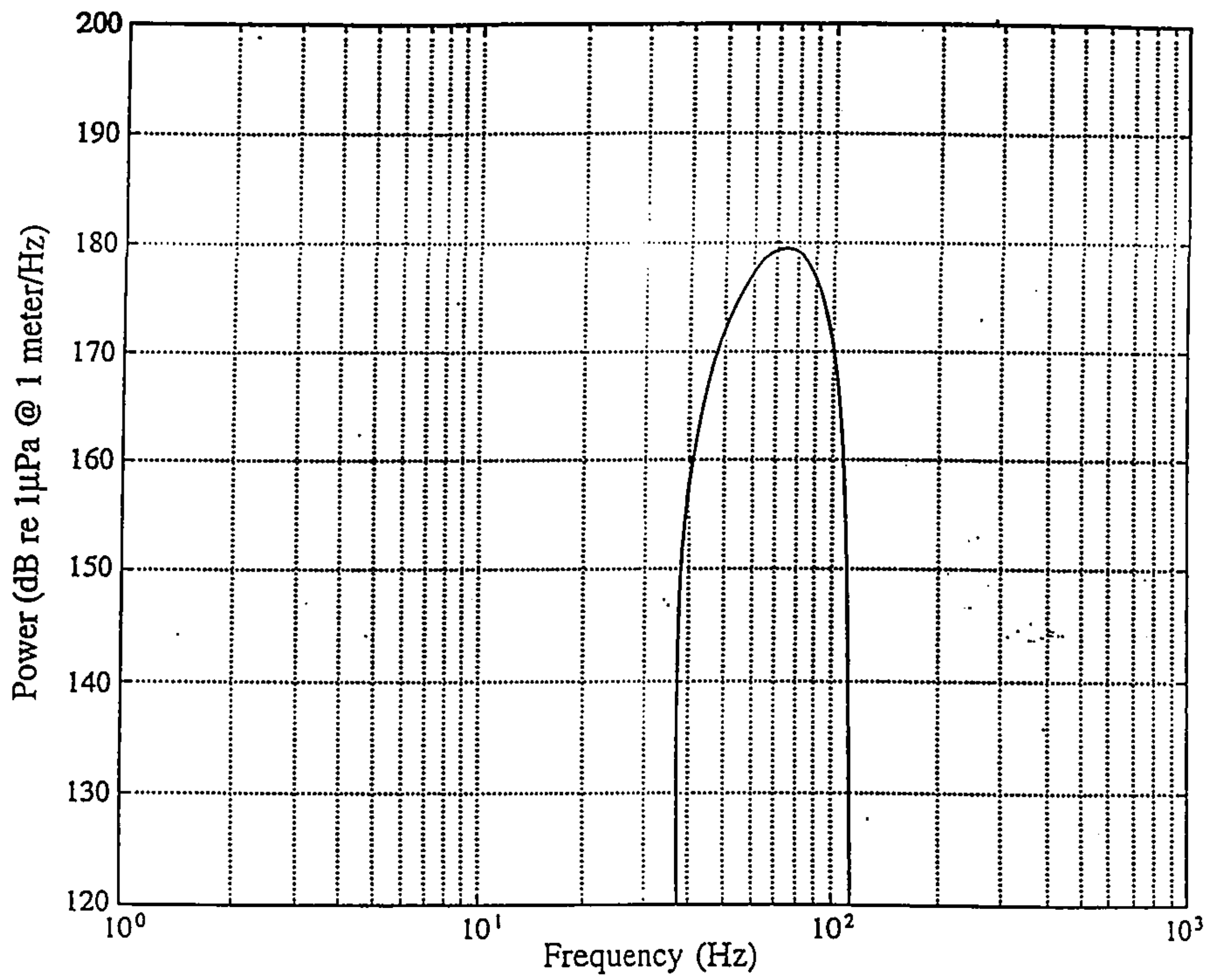


Figure 1.1.3-2 Kauai source power density spectrum

NOISE SOURCE	MAXIMUM SOURCE LEVEL	REMARKS	REFERENCE
UNDERSEA EARTHQUAKE.	272 dB	Magnitude 4.0 on Richter scale (energy integrated over 50 Hz bandwidth)	Wenz, 1962.
SEAFLOOR VOLCANO ERUPTION	255+ dB	Massive steam explosions	Dietz and Sheehy, 1954; Kibblewhite, 1965; Northrop, 1974; Shepard and Robson, 1967; Nishimura, NRL-DC, pers. comm., 1995.
AIRGUN ARRAY (SEISMIC)	255 dB	Compressed air discharged into piston assembly	Johnston and Cain, 1981; Barger and Hamblen, 1980; Kramer et al., 1968.
LIGHTNING STRIKE ON WATER SURFACE	250 dB	Random events during storms at sea	Hill, 1985; Nishimura, NRL-DC, pers. com., 1995.
SEISMIC EXPLORATION DEVICES	212-230 dB	Includes vibroseis, sparker, gas sleeve, exploder, water gun and boomer seismic profiling methods.	Johnston and Cain, 1981; Holiday et al., 1984.
FIN WHALE	200 dB (avg. 155-186)	Vocalizations: Pulses, Moans	Watkins, 1981b; Cummings et al., 1986; Edds, 1988.
CONTAINER SHIP	198 dB	Length 274 meters; Speed 23 knots	Buck and Chalfant, 1972; Ross, 1976; Brown, 1982b; Thiele and Ødegaard, 1983.
ATOC SOURCE	**195 dB**	**Depth 850 m; Average duty cycle 2-8%**	**EIS for the Kauai ATOC Project and MMRP, 1995.**
HUMPBACK WHALE	192 dB (avg. 175-190)	Fluke and flipper slaps	Thompson et al., 1986.
SUPERTANKER	190 dB	Length 340 meters; Speed 20 knots	Buck and Chalfant, 1972; Ross, 1976; Brown, 1982b; Thiele and Ødegaard, 1983.
BOWHEAD WHALE	189 dB (avg. 152-185)	Vocalizations: Songs	Cummings and Holiday, 1987.
BLUE WHALE	188 dB (avg. 145-172)	Vocalizations: Low frequency moans	Cummings and Thompson, 1971a; Edds, 1982.
RIGHT WHALE	187 dB (avg. 172-185)	Vocalizations: Pulsive signal	Cummings et al., 1972; Clark 1983.
GRAY WHALE	185 dB (avg. 185)	Vocalizations: Moans	Cummings et al., 1968; Fish et al., 1974; Swartz and Cummings, 1978.
OFFSHORE DRILL RIG	185 dB	Motor Vessel KULLUK; oil/gas exploration	Greene, 1987b.
OFFSHORE DREDGE	185 dB	Motor Vessel AQUARIUS	Greene, 1987b.
OPEN OCEAN AMBIENT NOISE	74-100 dB (71-97dB in deep sound channel)	Estimate for offshore central Calif. sea state 3-5; expected to be higher (≥ 120 dB) when vessels present.	Urick, 1983, 1986.

Note: Except where noted, all the above are nominal total broadband power levels in 20-1000 Hz band. These are the levels that would be measured by a single hydrophone (reference 1 μPa @ 1 m) in the water.

Table 1.1.3-1 Natural and human-made source noise comparisons.

power levels within each one Hertz portion of the ATOC transmission spectrum. Broadband levels are the total power over a specified bandwidth or portion of the spectrum emitted by a sound source; in Figure 1.1.3-2, for example, the broadband power level would be equivalent to the total area under the spectral curve. This is the reason why the ATOC source has a peak spectral value of approximately 180 dB, and a total power level of 195 dB.

Comparing sound levels in air and water must also be done carefully. First, due to convention, the reference pressure values are different by 26 dB. Second, due to the relative impedance of air and water (the stiffness or density of the medium), a roughly 3550 times greater power level (35.5 dB) is necessary in air than in water to produce an equivalent pressure level. Combining these two factors, a 61.5 dB difference or correction factor between the two scales is required -- a conversion factor that produces equivalent acoustic intensity values. This is why the 260 watt ATOC source produces 195 dB water-standard sound levels, while a 260 watt acoustic source in air would produce only a 133.5 dB air-standard sound level. Because of these complications, the National Academy of Sciences, National Research Council has noted that "great care must be taken in comparing sound levels in air with sound levels in water." (National Research Council, 1994). Given this potential for confusion this EIS generally avoids cross-media comparisons between air and water. All sound values presented in this EIS are water-standard values unless otherwise specified. Also, unless otherwise stated, all references are broad-spectrum values (20-1000 Hz) standardized at 1 micropascal at 1 m (1 μPa @ 1 m).

1.1.5 SUMMARY OF PREVIOUS OCEAN CLIMATE RESEARCH--DIRECT TEMPERATURE MEASUREMENTS; THE HEARD ISLAND FEASIBILITY TEST

In the past, measurements of ocean temperatures have been taken through direct readings from thermometers lowered from research and other vessels. Oceanographic research ships are used to sample the vertical temperature structure of the ocean, along "sections" across ocean basins. These sections each take many weeks to complete, and are rarely repeated. An exception is the 24°N (latitude) section across the Atlantic, which was first sampled in 1957. Sampling has been repeated twice in thirty-five years, and the changes in deep ocean temperature with time along that section are shown in Figure 1.1.5-1. An analysis of the data from these repeated samples reveals that there is some evidence of warming at depth, on the order of 0.007°C/year. This warming is similar to some modeled estimates of greenhouse-induced warming in the ocean. However, this 24°N section is virtually unique in modern oceanographic history -- very few repeated measurements like this exist, as they are very costly and tedious to repeat. Also, one or two isolated repeat sections are not enough to demonstrate whether the oceans are warming or cooling, overall.

Lowering temperature sensors from slowly moving ships is an inefficient and unreliable way of monitoring large-scale ocean temperature variability. Before large-scale measurements can be completed, the ocean changes, and measurements at each point are "contaminated" by small-scale ocean variability. Acoustic techniques rapidly and directly provide the large-scale averages that are required for global climate modeling purposes. The Acoustic Thermometry of

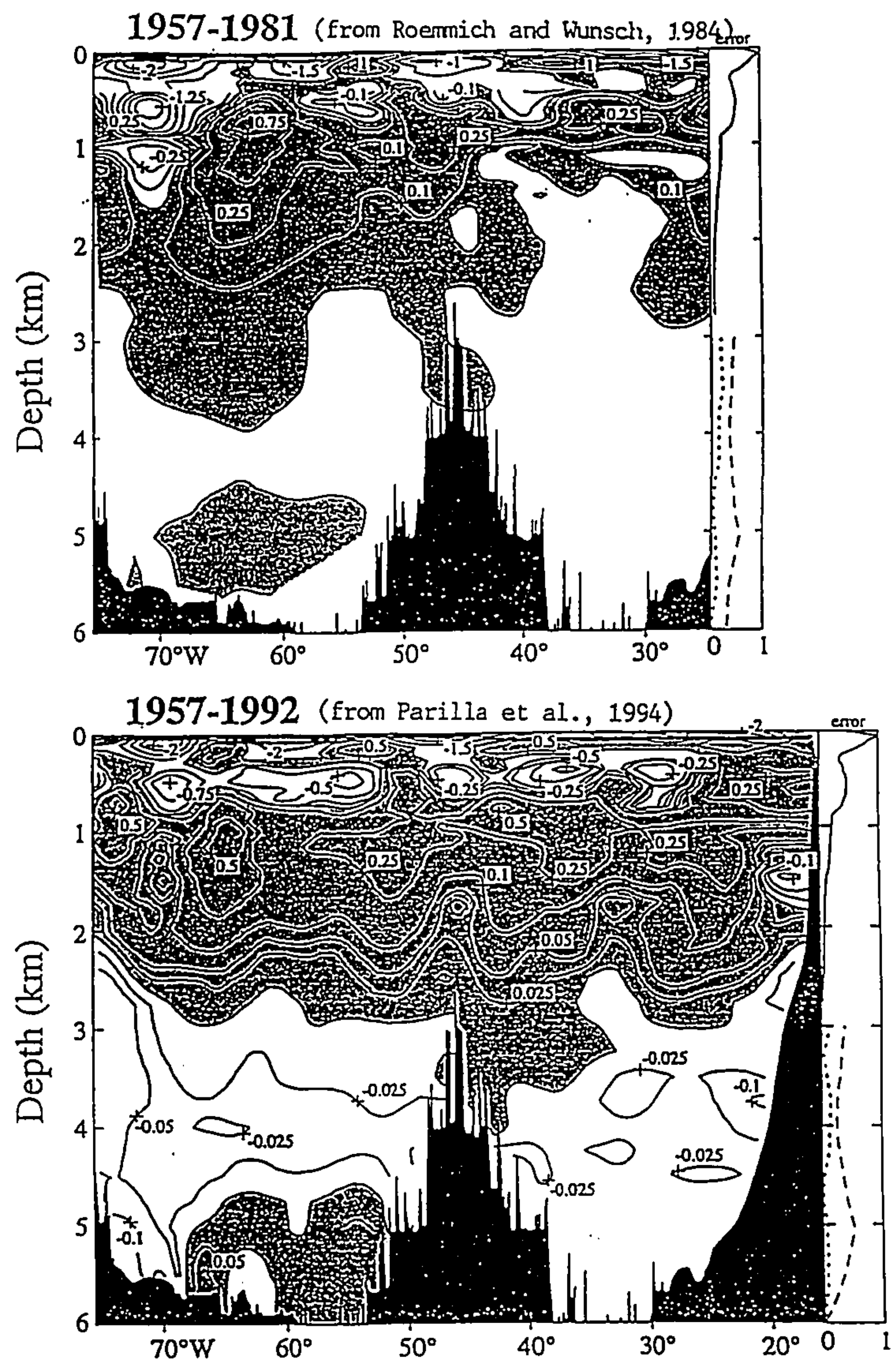


Figure 1.1.5-1 Ocean temperature changes (C) from base year at 24 deg N Atlantic Ocean

Ocean Climate project would allow the measurement of average ocean temperatures along tens of sections, many times each year.

Previous experiments provide the framework for the MMRP and acoustic thermometry efforts. One of these experiments was a ten-day exploratory feasibility test conducted in 1991 near Heard Island, a remote site in the southern Indian Ocean. Low frequency acoustic signals were transmitted from underwater acoustic sources suspended from a research ship. Nine nations manned 14 receiver stations, spanning the world's oceans. This experiment sent coded, low frequency, acoustic signals through the deep sound channel to receivers as far away as Bermuda and the California coast, 18,000 km away. The Heard Island Feasibility Test (HIFT) demonstrated the feasibility of using coded low frequency sound signals over long distances to measure average ocean temperature. However, HIFT was limited to a duration of just a few days and employed a non-stationary sound source, so long-term climate variability could not be characterized.

A warming in the deep sound channel on the order of 0.05°C per decade (which is the order of magnitude that climate models predict) would cause a decrease in the signal travel time of 1.5 sec per decade for a 10,000 km transmission path. It is expected that the ATOC system would be able to resolve changes of travel time on the order of 0.01-0.1 sec, therefore offering the potential for resolving the emerging patterns of global-scale temperature changes in the oceans.

In addition to seeking evidence of global-scale ocean warming as a result of the greenhouse effect, ATOC has the potential to detect relatively short-term events such as El Niño, which can change regional ocean temperatures by up to several degrees Celsius; changes of this magnitude are comparable to increases predicted from global warming over periods as long as a century. Also measurable will be the large-scale variability of ocean temperatures due to ocean currents. Some of these natural variations, known as mesoscale variability, are relatively small in scale (100 km). By acoustically measuring average temperatures across distances extending to 5000 km or more, over extended time periods, short-term regional and mesoscale variations would be averaged out, and the predicted global ocean climate warming "signal" would be detectable. Even before global climate change is evident in the data, ATOC would be able to contribute valuable sea-truth data to the climate-research modeling community, to improve their predictive capability. ATOC would be one component of the available techniques used for menasuring thermal variability (see Section 2.2 for discussions of the other techniques).

1.1.6 DESCRIPTION OF THE PROPOSED KAUAI FACILITIES

The proposed Kauai facilities consist of a sound source, comparable in size to a large water heater, connected to shore by a power cable. The unit is designed for easy retrieval and is planned to be removed at the completion of the experiment.

• Acoustic Source: Produced by Alliant Techsystems, the ceramic bender-bar acoustic source is roughly 2.1 m high by 0.9 m in diameter (comparable in size to a large water heater) and weighs 2268 kg. It is contained in a 3.7 m high, galvanized steel tripod frame, illustrated in

Figure 1.1.6-1. Total weight of this unit in air is 5443 kg; in water its weight will be about 4536 kg. The source is isolated from the frame with shock mounts. There are 3 nitrogen gas bottles for pressure compensation, to equalize the internal pressure with the external pressure of the deep ocean. The connector from the sea cable mates with a transmit/receive network which connects either the source or its integral receiver to the sea cable. The source-mounted receiver package has a tilt sensor, temperature and pressure sensors, and 4 hydrophones, all collectively termed the receiver. The hydrophones are on a 100 m line with a phone spacing of 33 m. For deployment, the hydrophone array will be coiled in a plastic container. After 3 days, corrosive links will part and a 60 cm (24 in) syntactic foam float will pull the array up. The tilt sensor on the tripod will transmit its signal acoustically (frequency proportional to tilt), as well as via the source cable. All pressure cases are plated mild steel with double o-ring seals. All exposed electrical cables are protected by encasement within either a protective steel pipe or a rubber hose.

The sound source is a prototype developed for this project. All components have a design life in excess of 10 yrs with a minimum guaranteed design life specification of 3 yrs. Following the initial demonstration experiment, the source can be recovered from the seabed.

The acoustic signal has been designed as a digitally coded sequence optimized for decoding at the distant receivers. It is not a pure 75 Hz tone; rather, it is a rapidly phase-switched sound within the nominal 57.5-92.5 Hz band. The acoustic source is a resonant source, which means that it works most efficiently in a narrow frequency band. As a result, the source cannot serve as a "loudspeaker" to broadcast broad spectrum sounds (e.g., tapes of whale calls).

• Source Site: The proposed source site is 14.7 km (8 nm) north of Haena Pt., which is approximately 6 km west of Hanalei Bay, Kauai (Figure 1.1.6–2) at 22°21.0' N, 159°34.2' W. Placement of the sound source would be at a depth of approximately 850 m. At this location, the bottom slope is about 9°.

• Source Sea Cable: The source power/monitoring cable is approximately 51.5 km long (27.8 nm). It is a type SD List 1 (nominally 2.5 cm diameter), coaxial, twin conductor, insulated cable, which would connect the source to an existing cable interface 1.3 km (0.7 nm) offshore at Barking Sands. The cable route was selected based upon side-scan sonar bathymetric surveys conducted in March and May of 1993 by Seafloor Surveys International, Inc. (SSI) of Kailua, Hawaii. Survey results are described in the *Final Survey Report for Kauai Acoustic Thermometry of Ocean Climate Site*, SSI 1993.

The route identified runs around the north and northwest side of Kauai (Figure 1.1.6-3) at depths ranging from 24 m to 850 m depth, but generally at about 70 m to 90 m depth. The route was established so as to run the cable along a flat path avoiding cable suspensions and rough surfaces, like coral. From the point of connection offshore from Barking Sands, the cable route moves into deeper water, passing along sandy surge channels which transect the outer reef. The cable was laid on the seafloor, with no alteration of existing contours.

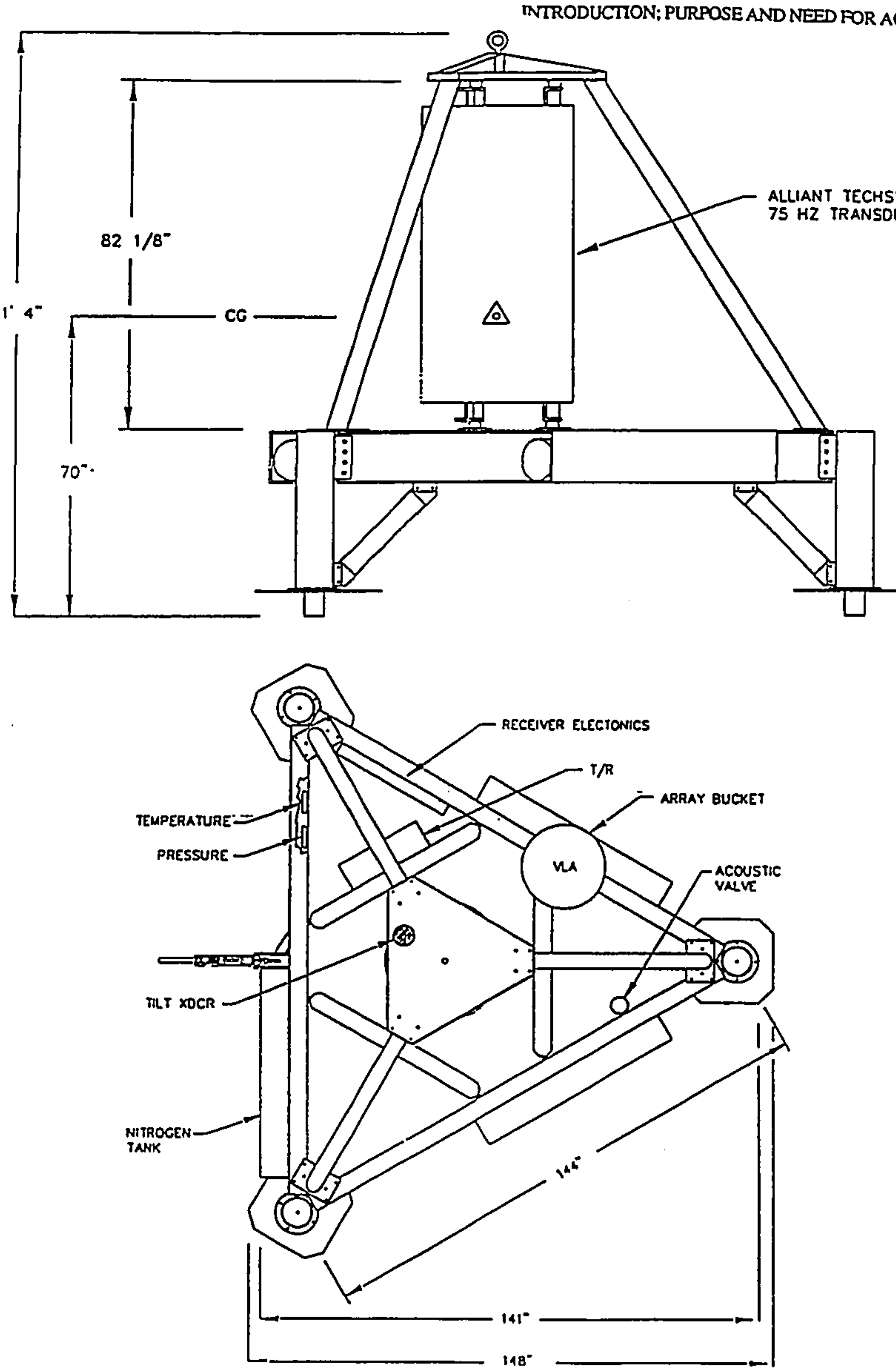


Figure 1.1.6-1 Kauai acoustic (line drawing)

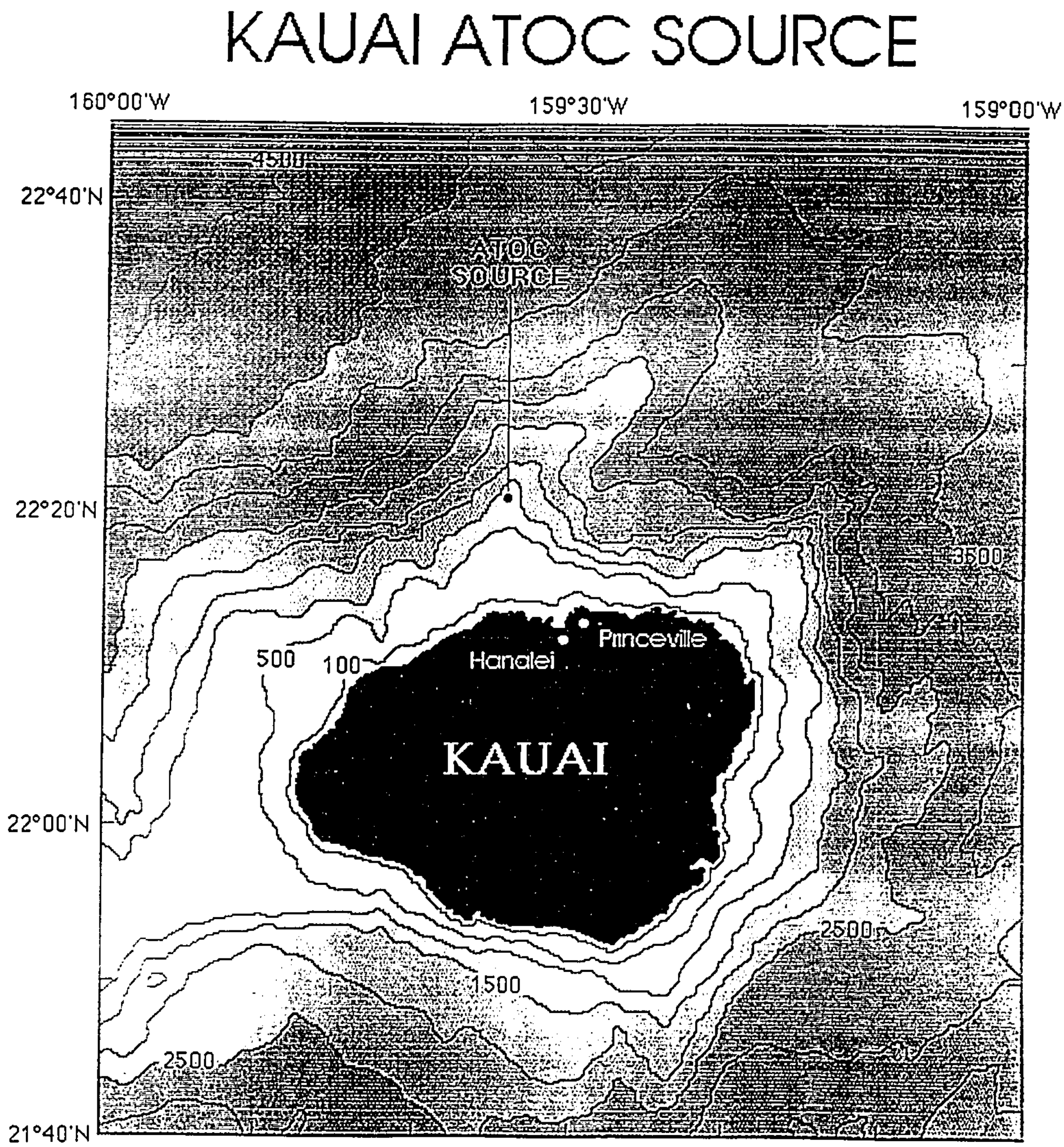


Figure 1.1.6-2 Proposed Kauai source site

Kauai ATOC Cable Route

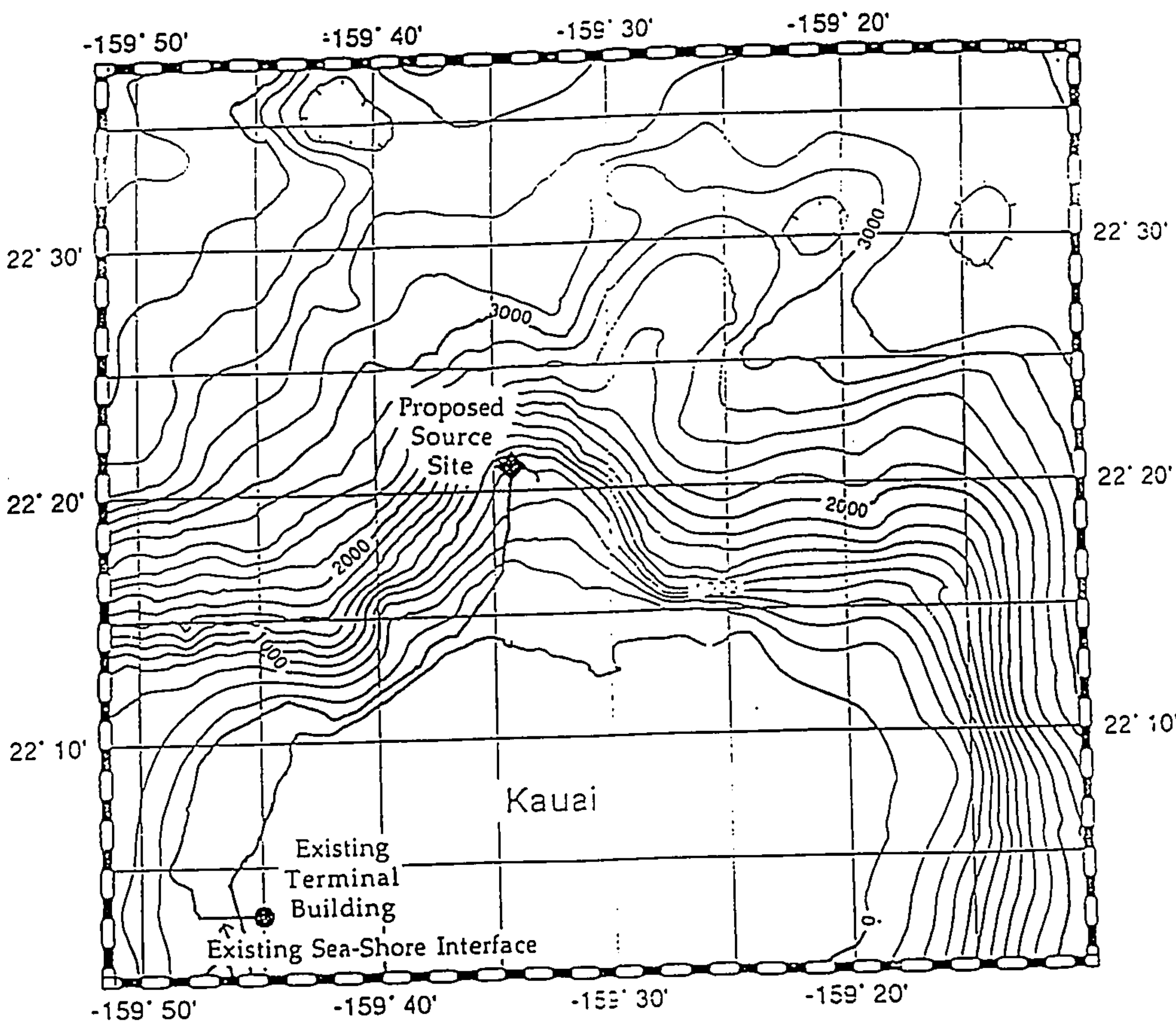


Figure 1.1.6-3 Proposed Kauai source cable route

The source has not yet been installed. The procedure for deploying the source would be first to recover the cable end, attach it to the source on deck, reposition the ship, then lower the source and cable to the seabed. Its final position would be precisely determined using an array of four acoustic transponders, which would be recovered via an acoustic signal after the source's final position has been determined.

• Subsea Listening System: The MMRP would use the source-mounted VLA to collect acoustic data in the vicinityof the source site, potentially out to a range of 20-40 km. Data collected from this array would enable the MMRP to apply passive acoustic array techniques to detect and record vocalizing whales (songs) primarily; although some capability would exist for detecting dolphin calls. This acoustic listening system would operate on a continuous basis, 24 hrs a day, even when visibility conditions are unsuitable for visual surveys (due to fog, high seas, darkness, etc.). See Appendix C for more details of the research protocol involved with this system and an associated statistical power analysis.

Over the course of one to two field seasons, the array should help provide data to help determine any potential effect the source may have on whales that vocalize, particularly those great whales that are suspected to rely on low frequency acoustics for communication.

1.1.7 ACOUSTIC ENGINEERING TEST (AET)

An Acoustic Engineering Test (AET) of one of the project sound sources was conducted at a remote location, 550 km southwest of San Diego, 3400 km northeast of Hawaii, from November 16 to 27, 1994. The AET was carried out pursuant to an EA and finding of no significant impact adopted by ARPA. Following incorporation of mitigation measures suggested by NMFS into the research protocols for the test, NMFS had no objections to ARPA's finding of no significant impact. Revisions of the research protocols were designed to ensure that there would be no taking of marine mammals.

The source was suspended at 650 m depth beneath the Scripps Research Platform "FLIP." Fifty-seven 20 minute transmissions were made during the 7 days on site. Specific test guidelines included the cessation of transmissions if any marine mammal was detected within 15 km of the source during a transmission or cancellation of a scheduled transmission if any marine mammal was detected within 15 km of the source prior to a transmission. Three scheduled transmissions were canceled due to the presence of a dolphin within a 10 km radius prior to the onset of the signal. Of those marine mammal detections, two were acoustic (i.e., the dolphin was heard by underwater hydrophones, but not seen) and one was visual. Only one other marine mammal was detected, a blue whale, which vocalized for a short period between scheduled transmissions, but left the area well before the onset of the next scheduled transmission.

Although not a phase of or, prerequisite for, the proposed acoustic thermometry project, the AET served to test the performance of the computer-generated phase-coded waveform, or signal, which was "tuned" to result in the optimum output signal from the source during this short test. The source operated at sound pressure levels of 175-195 dB, transmitting acoustic signals to existing Navy-owned receivers off Adak, Alaska, and Centerville, Pt. Sur, and San Nicolas Island

California. After careful processing, receptions off New Zealand were detected from a drifting deep hydrophone that was deployed specially for the AET.

Two ATOC vertical line arrays (VLAs) were also deployed for the AET: one 80 km from the source and the other approximately 3400 km away, off Hawaii. Receptions from the VLAs will be used to examine the effects of internal waves on the transmissions.

1.1.8 LONG-TERM ATOC PROGRAM PLANS

During the scoping process for this EIS, several commenters requested that the document be prepared as a programmatic EIS for a complete long-term global monitoring system. However, at this time, the Acoustic Thermometry of Ocean Climate project is experimental and is subject to fundamental uncertainties about the extent to which acoustic means can detect ocean climate changes. Without the analysis of experimental results from ATOC's near-term program, the details of any long-term network are too speculative to allow meaningful analysis.

The proposed project described herein should serve as the foundation for designing a system to measure long-term global ocean climate change trends. It should be long enough to assess any potential short-term impacts on marine animals, particularly marine mammals and sea turtles, demonstrate the source technology, and evaluate localized and mesoscale ocean temperature variability. This initial phase should demonstrate that it is possible to construct and operate an affordable international network capable of detecting and characterizing ocean climate change. In this sense, the ATOC project described in this EIS is a demonstration experiment for a possible long-term program and is a foundation and resource for long-term marine animal research.

There are several key uncertainties that make the design of a long-term system impossible without knowing the results of the proposed project. Obstacles to the evolution to a long-term, global network include the following issues which must be resolved:

- Signal stability (coherence) - Can the signals be decoded at the receivers with the full predicted processing gain and time resolution and, if so, over which ocean paths?

- Internal wave field limits - Do the ocean's ambient internal waves limit signal stability at long ranges, and if so at what ranges, and what is their relationship to the frequency band of the signal?

- Acoustic propagation limits - What limits does the incoherent energy (noise) among deep ocean acoustic paths (modes) have on signal power levels -- that is, over what paths can signals be sent at less than 195 dB levels?
- Ocean boundary scattering - What deleterious effects to sound reflections/ propagation do the ocean bottom and surface have in the vicinity of the source sites?

- Sound intensity related disturbance of marine animals - To what extent do local sound fields of the 260 watt source disturb or affect the habitats and critical behaviors of nearby marine animals? Are habitats being denied and, if so, over what areas of the ocean?

This initial experimental ATOC effort should furnish the information to help answer these questions which, in turn, would help verify and validate climate models and determine the design of an optimal global source and receiver network needed for a long-term program.

In summary, the data necessary to support a programmatic EIS do not exist at this time, and without these data no basis exists for the proposal/approval of a long-term program. It is not possible to predict the features of a long-term research program at a level of detail necessary to support a programmatic EIS. If additional long-term research is proposed, beyond that included in the current project, the additional research activities would be subject to appropriate environmental review and applicable permitting processes.

1.2. OBJECTIVES OF THE PROGRAM

A statement of project objectives serves as the basis for the screening and evaluation of alternatives and discussion of mitigation measures. This subsection summarizes the objectives of both the MMRP and the ATOC feasibility effort.

1.2.1 MARINE MAMMAL RESEARCH PROGRAM OBJECTIVES:

- Assess the potential effects of ATOC sound transmissions on the relative distribution and abundance of marine animals (particularly marine mammals and sea turtles) within the 120 dB sound field (modeled at 100 m depth), so as to minimize uncertainties associated with determination of the significance of any effects.

- Obtain information to help evaluate what effects the ATOC sound transmissions could potentially have on the relative distribution, abundance and diving behavior of marine mammals and sea turtles.

- Identify mitigation measures to avoid the potential disruption of behavioral patterns of local marine animals, particularly marine mammals and sea turtles.

- Assess the level of any responses of indicator species to ATOC sound signals, particularly whether any marine mammal or sea turtle demonstrates an acute or short-term response (Table C-1) to low frequency sound transmissions with the ATOC source characteristics.

1.2.2 ACOUSTIC THERMOMETRY PROGRAM OBJECTIVES:

- Observe the ocean on the large space scales (3000 to 10,000 km) that characterize climate so that modelers will be able to 1) test their models against the average ocean temperature changes seen by ATOC over a few years, and 2) if, and when, the models prove adequate, use those same observations to "initialize" the models to make meaningful predictions.

- Develop and demonstrate the equipment necessary to undertake acoustic thermometry experiments, in particular, reliable low frequency sound sources.
- Prove the concept of using acoustic thermometry to measure ocean climate variability for global applications by establishing multiple acoustic pathways in the North Pacific.
- Obtain early baseline data on transmission times in Pacific pathways to compare with data that may be obtained in a follow-on global program, if such a program is approved.
- Determine the minimum source level and duty cycle necessary for obtaining valid climatic data.
- Characterize oceanographic factors that could affect the global climate "signal," such as tidal cycles, internal wave fields, and mesoscale variations, and determine the constraints they impose on the design of a future (conceptual) ocean monitoring system.
- Utilize existing U.S. Navy seafloor hydrophones to the maximum extent feasible to increase the number of acoustic pathways and, hence, the quantity of data at a relatively small cost.

1.3 PURPOSES OF THIS DOCUMENT

This EIS is intended to serve several purposes. Most immediately, it will support the consideration by NMFS of a scientific research permit for the MMRP. The EIS is also intended to provide the information necessary for other regulatory approvals of the proposed action, including, but not limited to, consultation under Section 7 of the Endangered Species Act, consideration of state permits, and other regulatory requirements. A listing of federal and state agency approvals for which this EIS will be used is shown in Table 1.3-1.

AGENCY	ACTION
National Marine Fisheries Service	MMPA/ESA Scientific Research Permit Federal ESA Section 7 Consultation
U.S. Army Corps of Engineers	Nationwide Permits
Hawaii Department of Land and Natural Resources	Conservation District Use Permit
Hawaii Office of State Planning	Hawaii Coastal Zone Management Program Consistency Certification
ARPA	Decision to Proceed

Table 1.3-1 Federal and state agency approvals for which this EIS will be used.

1.3.1 MARINE MAMMAL PROTECTION ACT/ENDANGERED SPECIES ACT RESEARCH PERMIT

Scripps currently has pending before NMFS an application for a scientific research permit to conduct marine mammal and sea turtle research using the ATOC source. The decision to be made by NMFS is directly connected to the scope of the actions, the alternatives, and potential effects, which are detailed in this EIS. The following comprise the decision options for NMFS:

- To approve the application as submitted (without modifications)
- To approve the application with modifications such as specific management constraints and/or mitigation measures
- To deny the application (No Action)

1.3.2 CONSERVATION DISTRICT USE PERMIT

Scripps' application for a Conservation District Use Permit is pending before DLNR. The scope of DLNR review and the applicable criteria are discussed in Section 5.2.2. DLNR will hold a public hearing on the proposal and consider written and oral comments from state, federal, and local agencies, as well as other interested persons. The following comprise the decision options for DLNR:

- To approve the application as submitted (without modifications)
- To approve the application with modifications such as specific management constraints and/or mitigation measures
- To deny the application

1.3.3 PROJECT FUNDING BY SERDP

The ATOC program is funded by the Strategic Environmental Research and Development Program (SERDP), which was established by Congress, who directed the Department of Defense (DoD) to expend a portion of its budget on environmentally-related issues. The goal of SERDP is to use some of the resources from the downsizing of the defense establishment to address environmental problems. The impetus has been to convert some of the assets of the DoD for dual, or non-military, uses. In the case of ATOC, these funds ($35M) are being administered through the Advanced Research Projects Agency (ARPA), the central research arm of DoD.

1.3.4 OTHER PERMITTING REQUIREMENTS

As discussed in Section 5, a number of additional regulatory reviews apply to the MMRP and Acoustic Thermometry of Ocean Climate project. These include the Hawaii Office of State

Planning's Coastal Zone Management Program's federal consistency review and the U.S. Army Corps of Engineers' nationwide permits. This EIS is intended to support these reviews as well.

1.4 SCOPING SUMMARY

The following discussion summarizes the NEPA and Chapter 343, Hawaii Revised Statutes (HRS) Hawaii Environmental Policy Act (HEPA) process to date, future activities under NEPA and HEPA, issues identified during the scoping process, alternatives identified during scoping, and major issues to be evaluated in this EIS. (Refer to Appendix D.)

1.4.1 NEPA REVIEW PROCESS

ARPA and NMFS are the joint-federal lead agencies for the purposes of this EIS. The environmental review process conducted under NEPA for the proposed project was initiated by the issuance of a Notice of Intent (NOI) to prepare an EIS on April 8, 1994 and published in the Federal Register on April 15, 1994.

In addition to the written scoping comments received by ARPA and NMFS, two public scoping hearings were held on April 15, 1994 and April 16, 1994, respectively, in Honolulu and Kauai, to solicit public comment on the range of issues to be addressed in the federal environmental review process. Public hearings soliciting public comments on the Draft EIS were also held on February 9, 1995 and February 10, 1995 in Kauai and Honolulu, respectively.

A 60-day Draft EIS review and comment period followed the filing of the Draft EIS with the Environmental Protection Agency (EPA). Following this review and comment period, ARPA and NMFS considered and responded to comments received and have prepared this Final EIS. In response to several requests by the public for an opportunity for additional participation in the EIS review and approval process, comments from the public are being solicited during the 30-day period ending June 26, 1995, following official publication of the Final EIS via the Federal Register.

1.4.2 HEPA REVIEW PROCESS

Upon consultation with the State DLNR and the Office of Conservation and Environmental Affairs' review of the conservation district use permit application, a determination was made that 1) The proposed use is a conditional use within the Resource subzone of the Conservation District according to Administrative Rules, Title 13, Chapter 2, a amended; 2) A public hearing pursuant to Section 183-41, Hawaii Revised Statutes (HRS), as amended, will be required in that the proposed use is of sufficient public interest; and 3) In conformance with Title 11, Chapter 200, of the Administrative Rules, and Hawaii Revised Statutes, Chapter 343, the Department has determined that an Environmental Impact Statement is required for the proposed action.

A joint EIS, which complies with both NEPA and HEPA requirements, is drafted for this purpose. DLNR is the State's accepting agency for the purposes of this EIS. The environmental review process conducted under Chapter 343, HRS was initiated by an EIS Preparation Notice published in the Office of Environmental Quality Control (OEQC) bulletin on October 8, 1994. A 30 day public comment period followed and closed at the end of business on November 7, 1994. All comments received within the 30 day public comment period have been considered and are incorporated into this EIS as Appendix F.

Following issuance of the Draft EIS, a 45-day public comment period was provided after which the Final EIS was prepared. No distinction was drawn between comments submitted under NEPA and comments submitted under HEPA. As with the Draft EIS, this Final EIS is a joint document fulfilling the requirements of both NEPA and HEPA.

1.4.3 ISSUES IDENTIFIED DURING SCOPING.

The scoping process resulted in requests that several environmental issues be analyzed in the EIS. All potentially *significant issues have been evaluated in this EIS.* A chronology of scoping activities associated with the preparation of this EIS is presented in Appendix D. A summary of significant issues identified during scoping follows:

• Scope of Project Analyzed: A variety of comments were received on the necessary scope of the project to be evaluated. Several commenters requested that this EIS not be restricted to the MMRP alone, but that it also evaluate the acoustic thermometry project. The project scope to be evaluated in this EIS encompasses the MMRP Pilot Study and the continuing MMRP in conjunction with the follow-on ATOC feasibility experiment.

Other commenters requested that a single EIS be prepared for the Kauai and California projects. A number of distinct differences between these program elements would make this type of combined analysis awkward. First, the number and genera of marine life in each site is greatly different. Second, the opportunities (and therefore information value) for marine mammal research (particularly boat and visual observations) are significantly different. Third, both the California and the Hawaii documents will be joint federal/state documents. All these factors, plus differing state requirements, militate against development of a single EIS for the two sites. Nevertheless, in an attempt to respond to this request, both the Kauai and California environmental documents are being processed on similar schedules. Those commenters interested in the California project should review and comment on the EIS for that project. In order to provide for a combined review, and even though public review schedules will not be precisely concurrent, the Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the California project is incorporated by reference into this Final EIS for the Kauai project.

A few commenters also requested that a single programmatic EIS be prepared on both the short-term and future long-term acoustic thermometry programs. However, any long-term ATOC program is highly speculative at this time, and cannot reasonably or feasibly be evaluated now in a programmatic EIS (see Section 1.1.7). Any future acoustic thermometry research efforts will be subject to applicable permitting and environmental review processes.

• Alternatives to be Considered: During the scoping process, a number of alternatives to the proposed action were suggested and evaluated. Commenters requested that the alternatives analysis include alternate source sites, alternative technologies for measuring global climate change, and alternative protocols for operation of the project source. The range of alternatives considered in Section 2 responds to this request.

• Biological Resources: Nearly all commenters requested that all biological resources that may be affected be evaluated, focusing on marine mammals, but also assessing impacts on sea turtles, seabirds, fish, and invertebrates. The overall organization and principal focus of this EIS responds to this scoping comment.

• Scientific Uncertainty: Many commenters highlighted the scientific uncertainty that surrounds the general question of marine mammal response to low frequency noise. The MMRP has been designed to address this uncertainty for purposes of determining whether the program is safe for marine animals, and this EIS presents the current state of scientific knowledge regarding those impacts.

• Justification for the MMRP: A number of scientists and other interested individuals and organizations requested that the EIS present the rationale, procedures, protocol, and anticipated results of the MMRP, focusing on the degree to which the MMRP is appropriately designed to determine whether adverse impacts to biological resources will result from source transmissions. This EIS responds to this request as a principal task.

• Source Suspension Guidelines: Several commenters requested that the EIS articulate a standard of harm that will guide whether source transmissions continue. They also requested that the EIS identify who will implement the standard and make decisions whether to proceed with transmissions. The MMRP Research Protocol included in Appendix C, and discussions elsewhere in this EIS, respond to this request.

• Effects on Tourism and Fishing: Many local commenters were concerned that adverse impacts on biological resources could have an indirect impact on tourism and fishing. These potential impacts are addressed in Section 4.

• Consistency with Humpback Whale National Marine Sanctuary and Land Use Plans, Policies and Requirements: A few commenters requested that the EIS discuss the consistency of the project in Hawaii with the Hawaiian Islands Humpback Whale National Marine Sanctuary Management Plan. Several commenters requested that the EIS evaluate the consistency of the project with land use plans, policies, and requirements. These issues are addressed in Section 5.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

This section describes a range of alternatives to the proposed project and briefly summarizes the environmental consequences of the alternatives. Both primary and secondary alternatives are considered. Secondary alternatives are those alternatives to the proposed action that would accomplish the action in another manner, such as through using a different technology. From the perspective of the acoustic thermometry element of the project, secondary alternatives include such technologies as moored autonomous sound sources, or direct measurements of ocean temperatures with conventional thermometers. Primary alternatives generally are considered to be variations of the proposed action, such as the installation of project facilities at alternative sites, and/or variations of the proposal through implementation of one or more mitigation measures.

Twelve alternatives, representing a range of options, are described, including the proposed action and the "no action" alternative. This section describes the twelve alternatives (including three alternate project sites) that were considered. The descriptions focus on the effectiveness of each alternative and its potential to meet the project objectives described in Section 1. Based on this analysis, four alternatives are selected for further study. Evaluation of these four alternatives against the project criteria are included at the end of this section (Tables 2.4-1). Potential environmental impacts of these four alternatives are described and compared in Section 4.

2.2 ALTERNATIVES CONSIDERED AND RATIONALE

The alternatives considered in this section include: 1) the proposed action (Kauai source site), 2) no action, 3) alternate project sites (three such sites are screened, including Midway Island, Johnston Atoll, and Adak Island, Alaska) (Figure 2.2-1), 4) moored autonomous sources, 5) restricted source transmission times, 6) modified source operational characteristics, 7) global climate models, 8) satellite sensors for sea surface temperature measurements, 9) satellite sensors for sea level measurements, 10) oceanographic point sensors (measurements using conventional thermometers), 11) autonomous polar hydrophones and 12) separating the MMRP and ATOC experimental sites using mobile sound sources.

Of the twelve alternatives considered, the proposed action, no action, one alternate site (Johnston Atoll), and moored autonomous sources have been selected for detailed consideration in Sections 3 and 4.

With the exception of Global Climate Modeling which is an integral part of the ATOC program, qualitative comparison of ATOC with other oceanic temperature measuring efforts, (e.g., Autonomous Lagrangian Circulation Explorer/Profiling Autonomous Lagrangian Circulation Explorer [ALACE/PALACE]) (see Section 2.2.10) is limited by differing objectives and products and are not directly comparable.

2.2.1 PROPOSED ACTION AND MITIGATION MEASURES (ALTERNATIVE 1)

This subsection describes the proposed action by Scripps, as stated in the Scientific Research Permit (SRP) application, and compares it to other suggested alternatives.

Section 1 of this EIS generally describes the overall program, the physical facilities, and the MMRP. The description of the proposed action here does not repeat this information, but instead incorporates and relies on the discussion in Section 1. The presentation here focuses on operational protocols for the proposed acoustic source and the resulting sound fields in the ocean. These protocols and sound fields are the principal features of the project that pertain to issues of environmental concern.

2.2.1.1 Proposed Action

The proposed action would involve the installation and operation of a low-frequency sound source 14.7 km (8 nm) north of Haena Point, Kauai. Originally, it was proposed that the source be operated six times every day for twenty minutes over a two-year period. Each source transmission would begin with a five-minute "ramp up," a slow increase in the sound volume, to the full 260 watt, or 195 dB source level. Marine mammal research would have occurred against the backdrop of this operational protocol.

In response to comments received during the scoping process, the proposed research protocol has been revised to now include an initial Pilot Study, involving operation of the source at a variety of levels and duty cycles, to allow more rigorous examination of the potential effects of the source on marine animals. Specifically, the following features are included:

- ATOC feasibility operations would not commence until after a Marine Mammal Research Program Pilot Study has been performed and reported on by marine biologists (approximately 180 days).

- The source operational protocol would include a variety of levels and duty cycles (source levels ranging from 185-195 dB, duty cycles ranging from 0-8%), offering experienced marine animal observers the opportunity to recognize any acute or short-term effects on marine animals (particularly marine mammals and sea turtles) (Table C-1), as well as any disruption in behavioral patterns.

- Marine animal habitat utilization observations would be conducted from the air (visual observations and surveys), from the shore (cliff-side visual observation sites), and from underwater (bottom-mounted hydrophone array passive acoustic monitoring).

- Acoustic surveys would be carried out from a boat, with calibrated hydrophones to record signal levels at various ranges in a systematic pattern around the source.

- Acoustic observations would include the area within the 200 m depth contour in the nearshore region between the source and the island, and also within the designated Hawaiian Islands Humpback Whale National Marine Sanctuary at Kilauea Point.

- Acoustic sampling would allow for comparative sound level measurements of existing noise-producing sources (whale-watching vessels, recreational power boats, pleasurecraft, low flying aircraft, etc.).

- Source operations would be suspended at any time that an acute or short-term effect (as described in Table C-1) is observed in association with the operation of the source. The protocols for suspending operations are described more fully in Appendix C.

- Field observational data would be processed and analyzed periodically during the MMRP Pilot Study and reported to all concerned (see Appendix C).

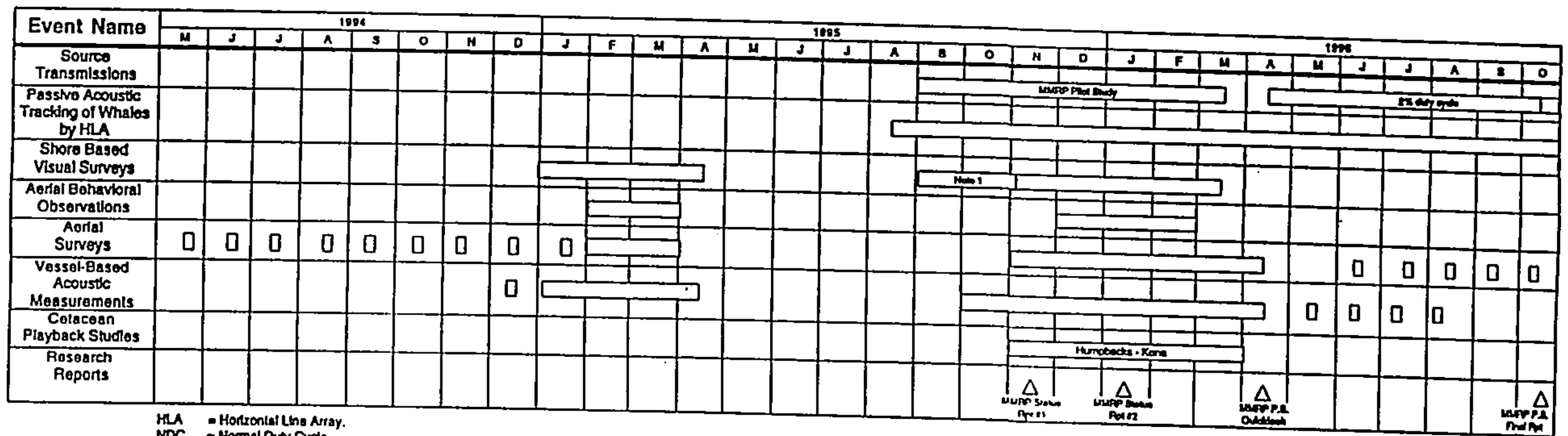
- After completion of the MMRP Pilot Study, a report of the preliminary results would be reviewed by ARPA, NMFS, the MMRP Advisory Board, the Marine Mammal Commission (MMC), The Marine Mammal Center (TMMC), and the proposed Kauai Community Advisory Group. It would be the goal of the project to complete this preliminary review within one month after the completion of the Pilot Study. Note: The MMRP Advisory Board is an independent panel of scientists, marine biologists, and marine mammal specialists assembled to provide advice and guidance to the MMRP. Its members include:

    - W. John Richardson (Chairman), LGL Ltd., Ontario, Canada.
    - William T. Ellison, Marine Acoustics, Inc., Newport, RI.
    - Peter Tyack, WHOI, MA (Currently at Stanford University)
    - Jeanette A. Thomas, Western Illinois University.
    - Judy Zeh, University of Washington.
    - Doug DeMaster (Observer), NMML, Seattle, WA.
    - Robert Hofman (Observer), MMC, Washington, DC.
    - Scott Eckert (Observer), Hubbs Sea World Research Institute, San Diego, CA.

- Results of this review would be used as part of the process to determine the optimum acoustic source parameters for acoustic thermometry feasibility operations.

- MMRP surveys and observations would continue throughout any follow-on ATOC operations, with data reviews and reports in accordance with SRP requirements (Table 2.2.1.1-1).

Several mitigation measures have been included in the proposed action, and are presented below (in italics). These have been developed generally to mitigate the potential for effects of ATOC subsea sounds on marine animals.



HLA = Horizontal Line Array.
NDC = Normal Duty Cycle.
TBD = To be determined.

Note 1: Single shore station

Table 2.2.1.1-1 Kauai MMRP schedule of events

Mitigation Measure A-1: A dedicated MMRP Pilot Study will precede ATOC feasibility operations as described in detail in Section 2.2.1 and Appendix C.

Contingent upon findings of no acute or short-term impacts (Table C-1) to marine animals during the MMRP Pilot Study, ATOC feasibility operations would be initiated. Transmissions would be for 20 min every four hours, every fourth day, with each transmission preceded by a 5 min ramp-up period (2% duty cycle). Following issuance of the final MMRP Pilot Study Report; i.e., about six months after the Pilot Study ends, approximately two months of transmissions at an 8% duty cycle (daily every four hours for 20 min) would be required to adequately sample the ocean paths for the possible effects of ocean tides and other high frequency fluctuations. The 2% duty cycle would be re-instituted following the 8% duty cycle tidal observations. Source levels would also be reduced to the minimum necessary to provide sufficiently strong signals at the receivers. The ability to reduce source power below the initial 195 dB source level (260 watts) would depend upon the efficiency of the actual sound transmission paths, ambient noise levels, and other factors, such as vertical mode structure relative to sound channel axis position, and potential amplitude and phase coherence degradation due to oceanographic features, such as internal waves.

Once ATOC feasibility operations commence, the MMRP protocol defined in the Scientific Research Permit (SRP) application would be continued. That is, marine animals would be observed throughout the study period to identify any significant adverse disruptions to their behavior. The Kauai MMRP Research Team (MRT) would quantify possible effects by comparing results obtained before the installation of the source, during periods when the source is on, and during periods when the source is off.

The effects of the proposed sound source on marine animals (including sea turtles), and particularly humpback whales, would be monitored by passive underwater acoustic tracking, shore-based visual observations, boat observations and aerial observations and surveys. In addition, playback studies are planned for humpback whales. These tasks are part of an integrated experimental approach designed to measure any effects of the low-frequency sound transmissions on marine animal distribution, behavior, and sound production. A proposed timeline of MMRP and ATOC climate research is summarized in Table 2.2.1.1-1. This is dependent upon a number of assumed criteria, such as the date by which required permits are received and the periods when species of interest are present in the study area. The schedule is therefore subject to change once these criteria are known.

Sound Fields

The potential impacts of sounds from the source on marine animals depend upon three factors: 1) the intensity of sounds at various subsurface locations, 2) the location of marine animals in relation to those sounds, and 3) the sensitivity of those animals to the sounds to which they would be exposed. The following discussion addresses the first of these factors--how loud is the source at different locations? Section 4 analyzes the second and third factors--what animals might be exposed to the source and how do those exposures compare to what is known about the sensitivity of those animals to the signals produced?

As discussed above, when it is operating at full intensity the source will produce approximately 260 watts of acoustic power, resulting in a sound level of 195 dB at one meter from the source. Few if any animals would be exposed to the source at this full intensity, since they would need to be immediately adjacent to the source, approximately 850 m below the surface, in order to receive a 195 dB sound level. In consideration of the potential impacts of this sound source on marine animals, it is therefore necessary to estimate the **received** sound levels (i.e., the sound levels at the marine animals actual location) based upon these **source** levels.

A number of models are available to predict sound levels at various distances from the source. The simplest of these models calculate spherical and cylindrical spreading of the sound field with distance. Spherical models are most appropriate in the three dimensional space immediately surrounding the source. At ranges from the source greater than the source depth, a two-dimensional cylindrical spreading equation is more applicable.

Spherical and cylindrical spreading models do not consider the possibility of attenuation or reinforcement of signal propagation paths due to the effects of the transmission medium (sea water) or surrounding features (the most significant of which are the sea bottom and the sea surface). The sea bottom exerts a strong influence on sound, by absorbing and reflecting sound energy, thereby decreasing or increasing the predicted received sound levels at a particular site distant from the source. Parabolic equation models address these attenuating and enhancing effects to produce a more realistic estimate of actual received levels. Parabolic equation model results for the proposed Kauai ATOC source installation are depicted in Figures 2.2.1.2-1 and 2.2.1.2-2. Calculations of ranges of the sound fields around the source are depicted in Figures 2.2.1.2-3 and 2.2.1.2-4, using spherical spreading to 1000 m, then the parabolic equation model results.

The original SRP application presented a number of theoretical "zones of influence" (ZOI), which were based upon spherical and cylindrical spreading models, and which applied a number of "worst-case" or "bounding" assumptions to predict a maximum potential impact on marine animals. Due to the conservatism of the assumptions made in the ZOI analysis, and the fact that their effects were added together, the ZOI analysis does not accurately state the potential effect of the sound source on marine animals. Since this EIS is required to analyze anticipated environmental impacts, and because the parabolic equation model provides the most accurate estimates of received sound levels, Finite Element Parabolic Equation (FEPE) acoustic performance prediction model values are used throughout this document.

The sound field contours included in the original SRP application are depicted in Figure 2.2.1.2-5 (sound field rings are depicted as: 5 km= 130dB, <500 m dive depth; 10 km = 130dB, <500 m dive depth; 25 km = 120 dB,.<500 m dive depth; 40 km = 130dB, < 500 m dive depth). By comparing this with the revised sound field estimates (Figure 2.2.1.2-6), it can be seen that the original sound field contours significantly overstated the area where received sound intensities would exceed 120 dB, largely due to the fact that the sound field calculations did not account for any attenuating factors other than distance. Figure 2.2.1.2-6 portrays parabolic equation model calculations for 100 m depth. The sound field at 100 m represents sound levels most likely to be encountered by the majority of marine animals near the source off Kauai. The 120 dB and 130

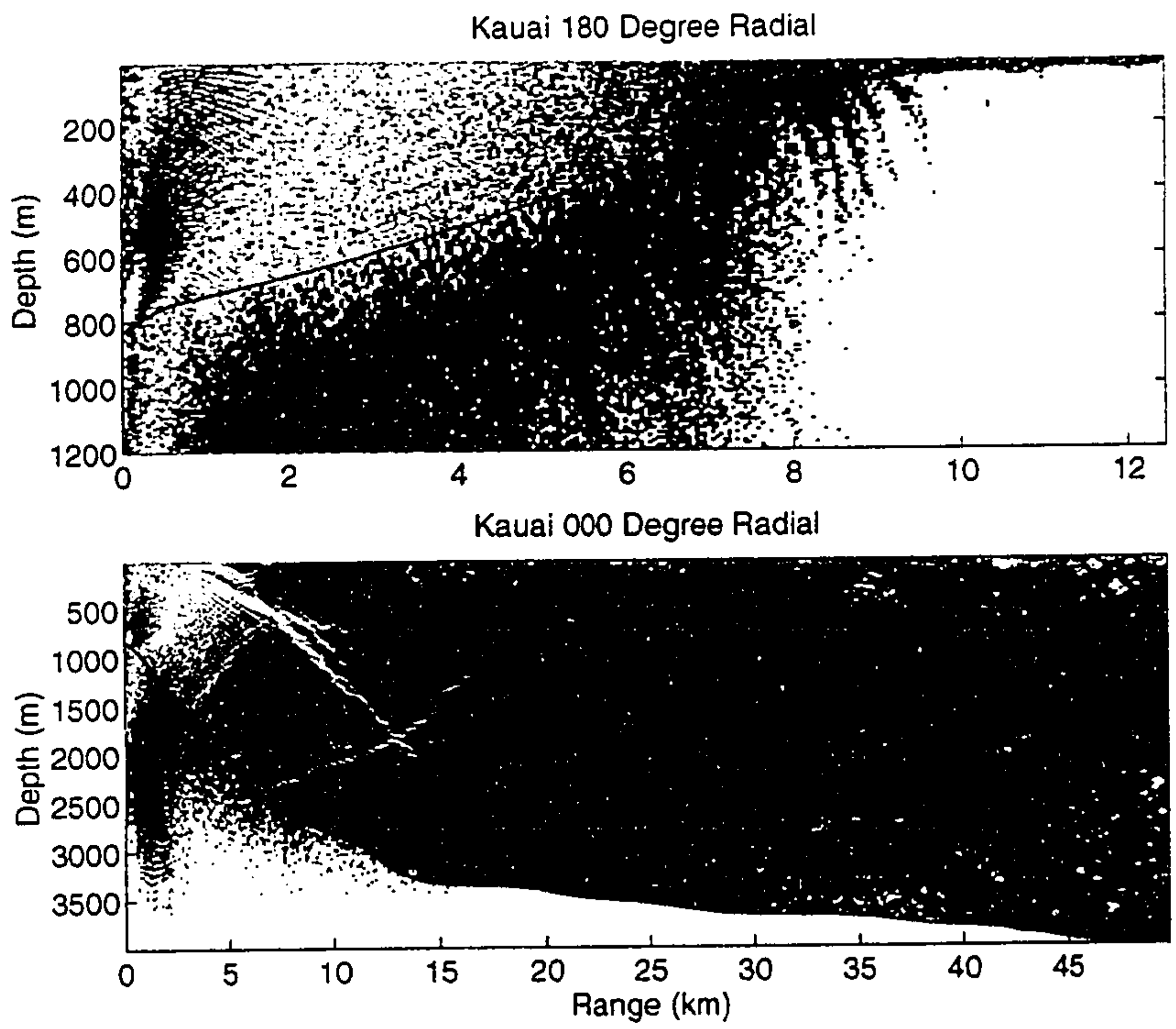


Figure 2.2.1.2-1 FEPE acoustic performance prediction model results (cross-section) (yellow color represents the 120dB sound field)

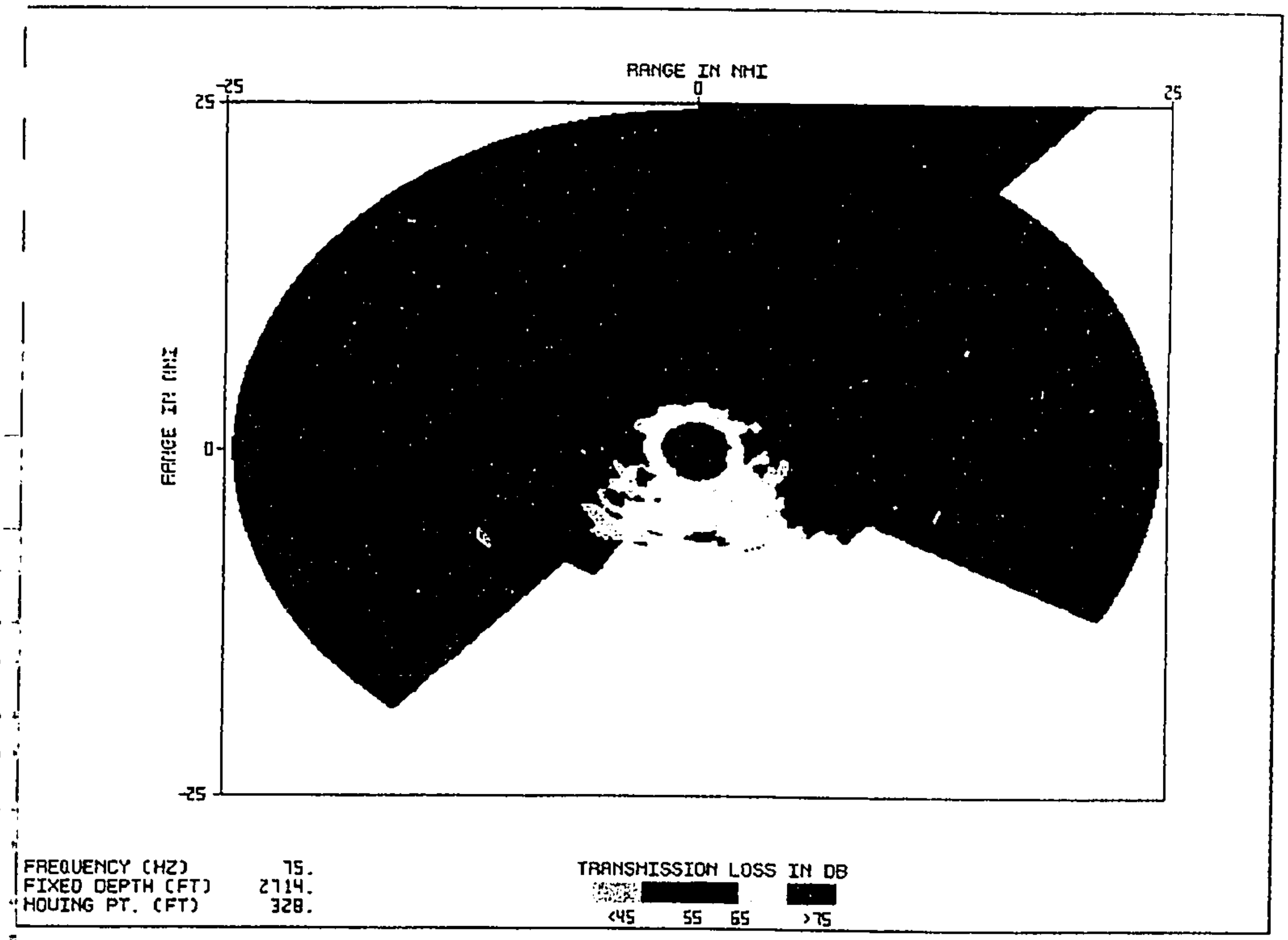


Figure 2.2.1.2-2 FEPE acoustic performance prediction model results (plan view) (yellow colored area represents the 120dB sound field)

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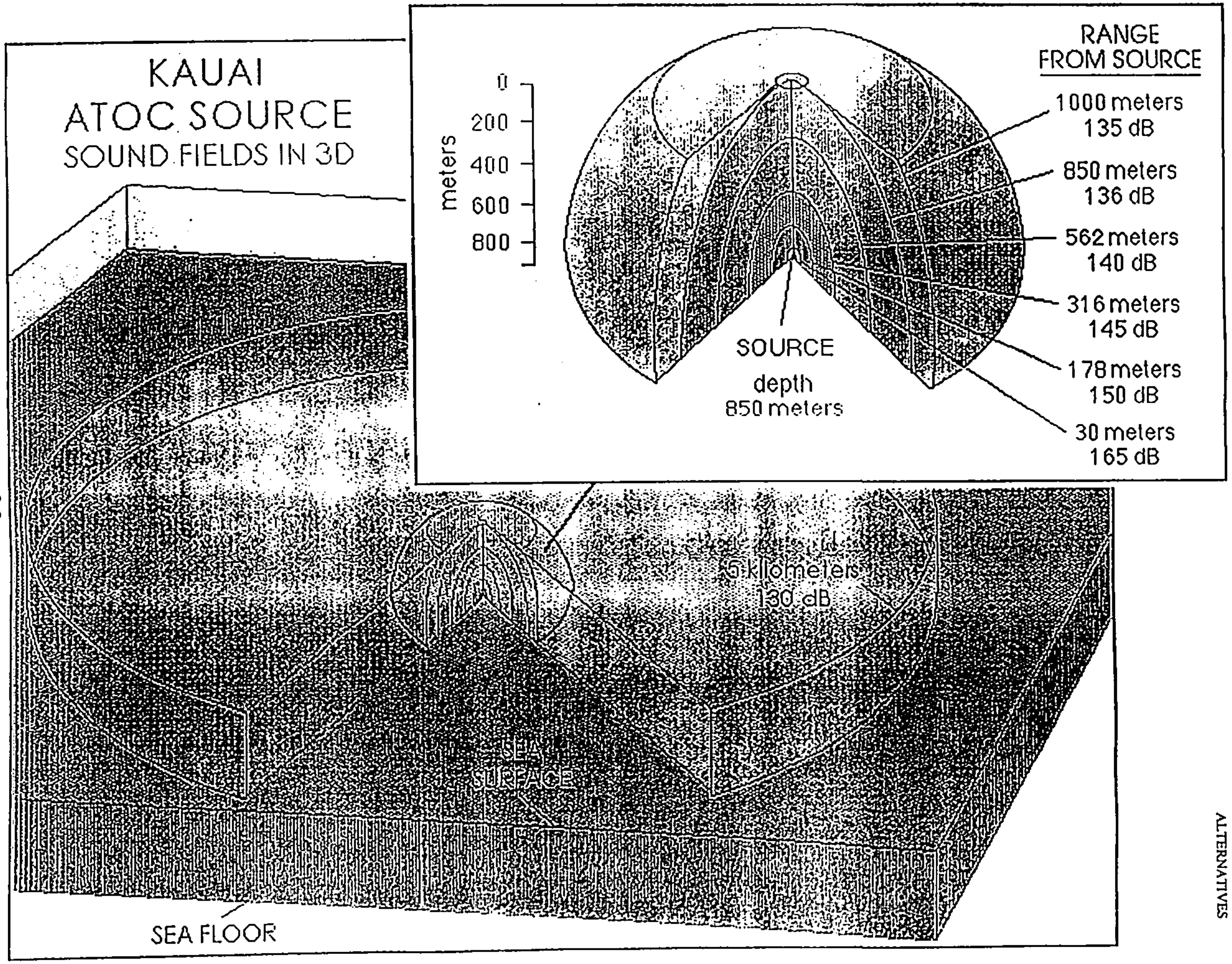

Figure 2.2.1.2-3 Kauai source sound fields in 3D

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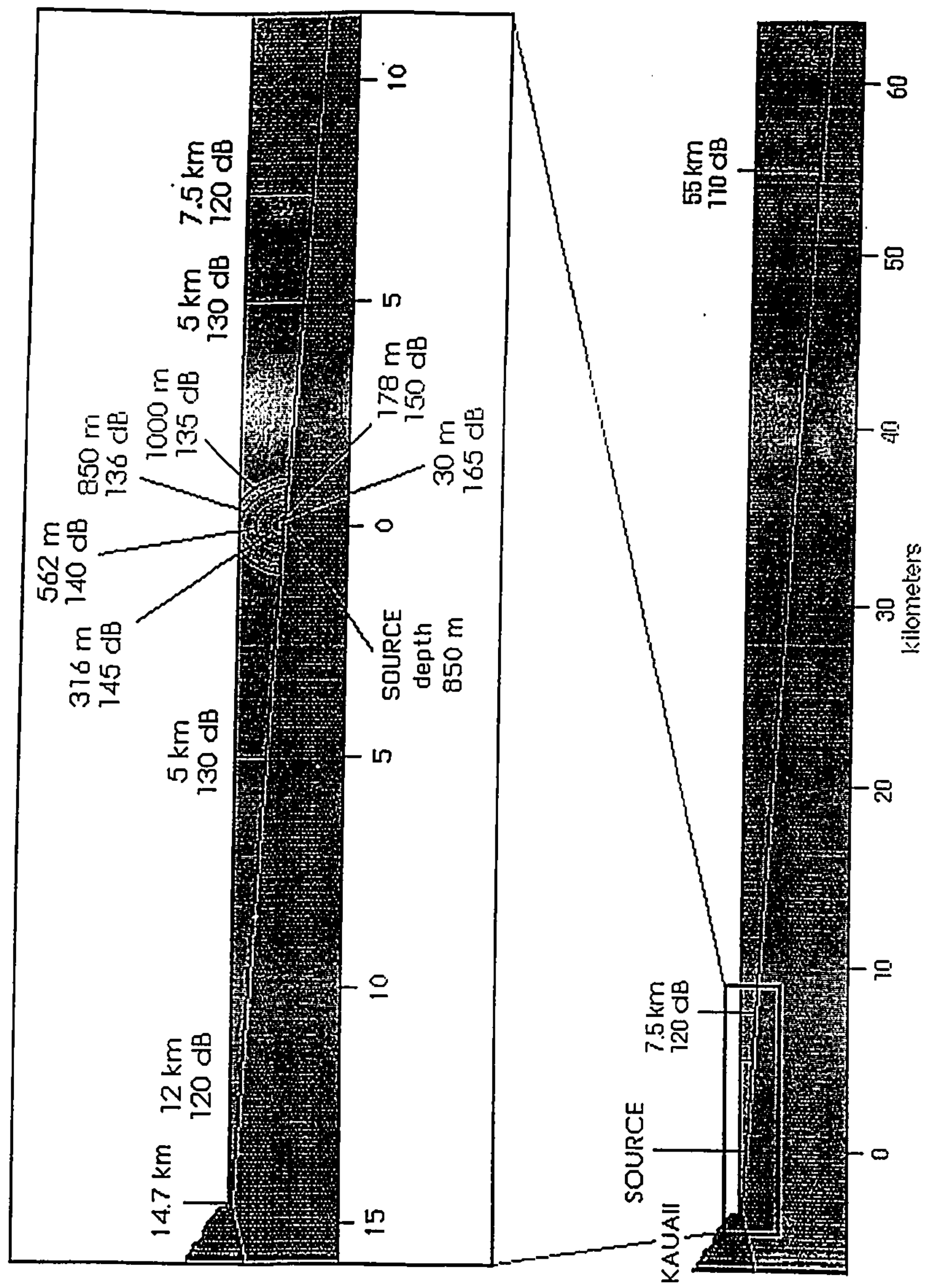

Figure 2.2.1.2-4 Kauai source sound fields - cross section (to scale)

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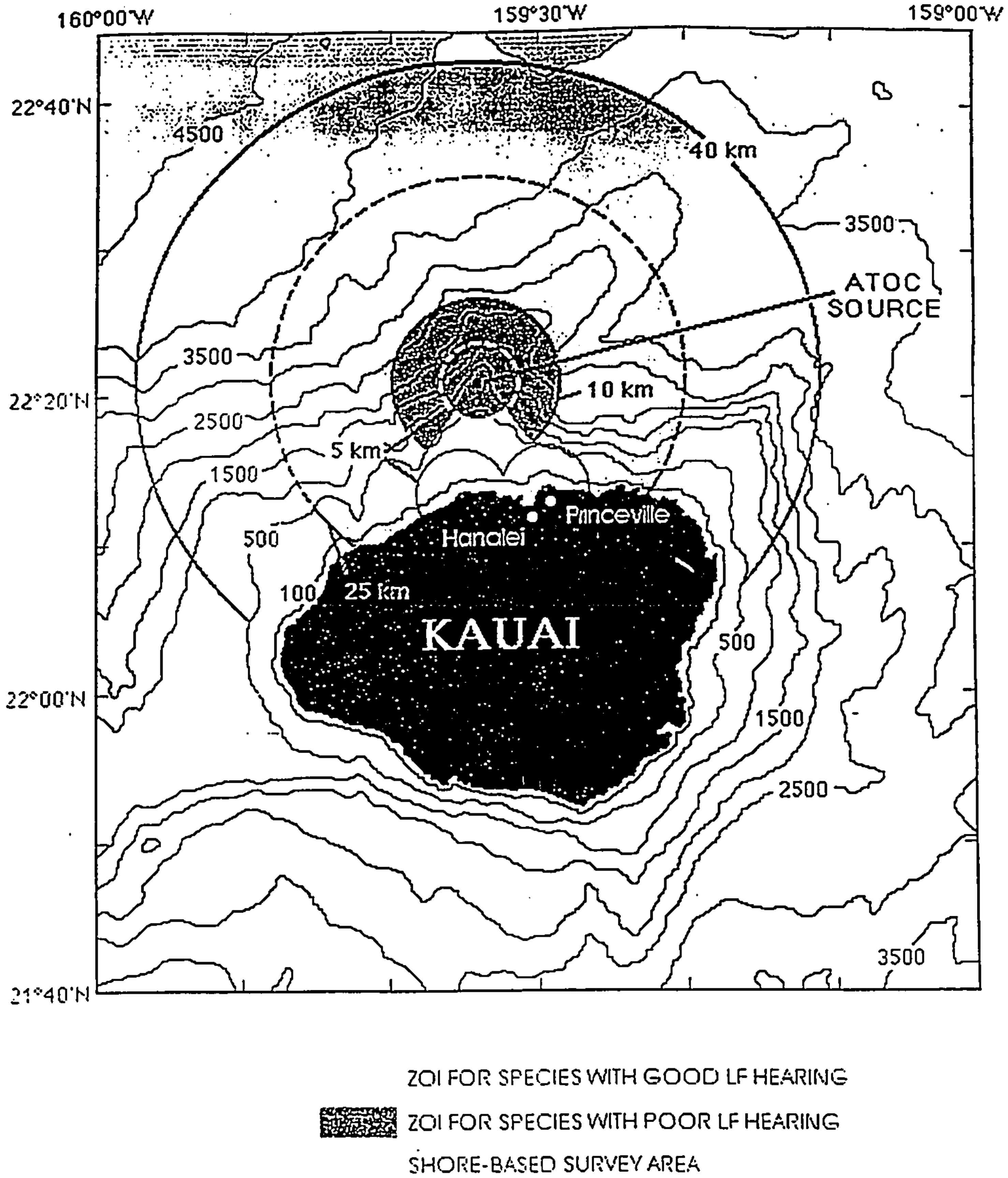

Figure 2.2.1.2-5 Original SRP application sound fields (10/25/93)

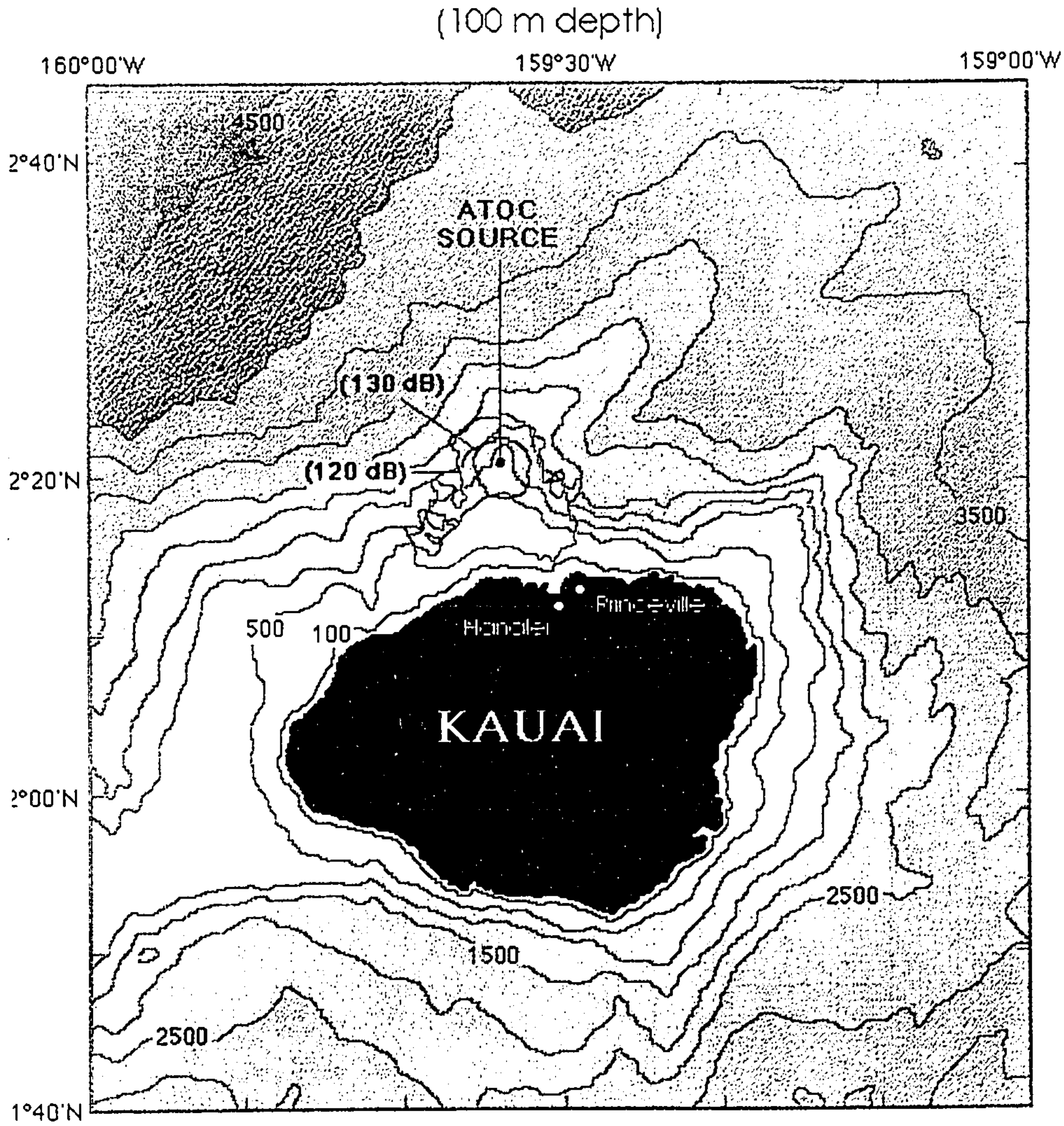

Figure 2.2.1.2-6 Kauai source sound fields (plan view)

dB sound fields are of smaller area at the 30 m and 500 m depths, and somewhat larger (approximately 10%) at the 850 m depth level.

2.2.2 NO ACTION (ALTERNATIVE 2)

Both NEPA and HEPA require that the proposed project be compared with a "No Action" alternative. This alternative would consist of not conducting the ATOC study, nor the associated MMRP. Under this alternative, no SRP would be issued by NMFS for the MMRP, the project facilities would not be installed, and neither the MMRP nor ATOC feasibility operations could commence. Results of an evaluation of this alternative are given in Table 2.4.1 at the end of this section. The environmental consequences of the No Action Alternative are further analyzed in Section 4.

Although the No Action Alternative would prevent any potential impacts from the ATOC source on marine animals, it would also delay or preclude both marine mammal research and ATOC feasibility efforts. Moreover, because this program offers the opportunity to collect important scientific data on the effects of low frequency sound on marine animals from natural and other human-related ocean activities, as well as ATOC (with safeguards built into the project design -- 23 mitigation measures [see Executive Summary] and source shut-down guidelines [see Appendix C]), and global climate change, taking no action at this time is not the preferred alternative.

2.2.3 ALTERNATE PROJECT SITE (ALTERNATIVE 3)

Under the Alternate Project Site alternative, the MMRP and acoustic thermometry projects would be undertaken with the source located at a site other than the north shore of Kauai. To put a reasonable bound on possible choices, this subsection first describes the process by which alternative sites were selected for analysis in this EIS.

An initial task in screening alternative sites for the MMRP and ATOC feasibility phase sources was the selection of an ocean basin and general source site areas that would best serve project objectives. Five factors proved to be particularly important in this regard.

First, an area is needed with a relatively large number of existing subsea listening arrays, in order to obtain the greatest number of acoustic pathways from each source, to sample the greatest volume of ocean. Since the North Pacific and North Atlantic basins were heavily instrumented during the cold war, and listening arrays in the southern hemisphere are much less numerous, a northern hemisphere study area was preferable.

Second, in comparing the Atlantic and Pacific Oceans, it was determined that the mid-Atlantic ridge, which acoustically tends to divide the North Atlantic basin, would complicate the ATOC acoustic investigations and limit the ranges over which the acoustic thermometry concept could be tested. A North Pacific study area was therefore preferred to avoid these problems.

Third, the sound channel tends to be deeper at lower latitudes (nearer the Equator), and deeper sound channel source locations are expected to enhance long distance propagation. Deeper source locations also reduce the received sound levels for marine animals in the upper part of the water column. This suggested use of lower latitude, temperate or tropical locations for the sources. Since many of the receiving arrays are in Arctic/Sub-Arctic waters, the combination of low latitude sources and high latitude receivers also results in the most efficient long distance pathways.

Fourth, at least two source locations were necessary to provide a sufficient number of acoustic pathways to cover the greatest ocean volume, preferably some of which would sample overlapping areas. In order to avoid redundancy, provide the greatest number of distinct pathways for each source and minimize the potential for traversing oceanic frontal systems (e.g., the Sub-Arctic front, where volumetric scattering and internal waves occur) and ocean mesoscale gyres (e.g., the California Current), broad areas were evaluated in the western Pacific, mid-Pacific and eastern Pacific for potential source sites.

Finally, since the ATOC project is led by investigators in the United States, source locations in the western Pacific were considered less feasible due to the long distances from the United States and the relative lack of United States possessions in that area. As a result, detailed site selection focused on identifying one source location in the mid-Pacific and one in the eastern Pacific. Site screening for source sites off the west coast of the United States is discussed in the California EIS. The site screening for the mid-Pacific source location is discussed below.

2.2.3.1 Site Survey

In developing the project proposal, potential locations in the Pacific Ocean were comprehensively surveyed. In the mid-Pacific, only a few locations are even feasible given the sparseness of islands, the fact that many of those islands are uninhabited, and the remoteness of many of those islands. These locations were initially assessed for their ability to provide long-range acoustic path geometry's needed for the viable study of ocean basin-scale circulation variability. This is a necessary step in understanding the sampling required to monitor ocean climate variability. This constituted the first cut of the possible sites and narrowed the field down to the four discussed below.

The following criteria were used to assess how well the alternate sites derived from the five screening factors cited above would achieve the MMRP objectives:

- Location at a site with sufficient populations of marine animal species of interest to ensure that researchers can obtain adequate data to produce statistically meaningful results.

- Location where there are baseline estimates of marine animal populations, preferably derived from calibrated field observation data.

- Location close enough to land to allow aerial surveys and observations from small aircraft, small boat acoustic data collection, and, if possible, shore-based visual observations.

- Location within the vicinity of other noise sources that can be studied (particularly ship/boat traffic), to allow researchers to compare the effects of various sources of noise on marine animals. [This is an opportunistic criterion; a lack of confounding human activities would facilitate MMRP research efforts. The fact that local noise sources are inherently prevalent can, in this case, be turned to a scientific advantage.]

- Location where meteorological (weather) and oceanographic (wave, swell, current) conditions are conducive to the conduct of at-sea measurement and data collection operations.

The following criteria were used to identify potential source sites that would achieve the acoustic thermometry feasibility objectives:

- Location at or near the deep sound channel axis, to provide the most efficient coupling of sound energy into this long distance sound duct, thereby reducing source power requirements (and nearby surface received levels).

- Location at a site with a clear acoustic "view" to existing and planned receiver locations (islands between sources and receivers block acoustic paths), preferably at a site that combines transmission pathways with large seasonal variations (e.g., to high latitude receivers) and pathways with small seasonal variations (e.g., to zonal or equatorial receivers).

- Location at a site that is locally flat (for secure placement), with a steep slope (18° optimum) in the direction of the receivers (to minimize bottom interactions with the transmitted signal that cause acoustic reflections and signal distortions).

- Location at a site with bottom surface features and opportunities for cable connections to shore that do not require extensive cable armoring or cable trenching.

- Location at a site with optimum bottom properties (sand sediment over basalt basement is best for good bottom reflection characteristics), and minimum bottom currents (to minimize deployment problems and the potential for source displacement once on the bottom).

- Location at a site that requires the minimum length of power cable to shore, to minimize cable costs and voltage requirements (most cables are voltage-limited).

- Location close to logistic support facilities, shore-based power, and communication nodes.
- Location in an area that allows the use of existing source technologies.
- Location in an area with minimal risk of damage due to bottom fishing.
- Location in an area with low potential for environmental consequences.

Siting criteria that increase the efficiency of the source sound transmissions (location in the sound channel, avoidance of adverse bottom conditions, etc.) permit use of a less intense sound transmission which, in turn, reduces the exposure of marine animals to noise. Source locations with views to a relatively large number of receiving locations permit the use of fewer sources (2) for a given number of pathways (up to 15). Locations that are logistically convenient reduce the energy use, vessel engine noise, air pollution and other effects of vessel trips to remote sites, and reduce the direct physical impacts of source facility installation. MMRP-related siting criteria are designed to increase the effectiveness of the research program, with corresponding environmental benefits that result from increased knowledge about marine animals.

The possibility of deploying the source off of a ship (by suspending over the side) in a remote area of the ocean was also studied initially. However, this potential alternative was eliminated because it is essential that the source be sited on a stable platform to ensure experimental accuracy and precision, and the long-term power and logistical requirements would be prohibitive. This scheme would also make it almost impossible to conduct a valid marine animal research program, since most such sites would be in locations where the logistics of long-term marine animal observations would be extremely challenging.

From an acoustic standpoint, ideally, the source would be located at the depth of the sound channel axis on a mooring in deep water far removed from sea bottom effects. However, this approach presents a number of engineering difficulties, discussed below in connection with the moored autonomous source alternative. The next best option would be to locate the source on the peak of a seamount, with the top at the depth of the sound channel axis. Unfortunately, most seamount configurations do not meet this criterion, and the tops of seamounts are not sharp peaks, but usually rounded. Thus, it is difficult to obtain a wide acoustic view. In addition, some seamounts are associated with upwelling that could relate to abundances of organisms.

A wide horizontal field of acoustic view is important because it defines how large a geographical area can be studied. Relatively steep slopes are required to obtain clean, downward-transmitted energy. Bottom interaction with the transmitted signal path is undesirable for two reasons: 1) useful energy for sampling different parts of the ocean is lost in the sediment, and 2) bottom-interacting energy could contribute to signal distortion at the receivers. The goal is to site the source so that upward-transmitted energy clears the bottom at its first lower refraction (turning) point, and downward-transmitted energy paths are free from bottom interaction.

Although the full range of potential mid- and north-Pacific source locations was evaluated during the initial site screening process, only four of those sites were sufficiently promising to receive detailed consideration. Specifically, applying the criteria described above, four potential project sites were selected for more detailed analysis here:

- Kauai, Hawaii (proposed action)
- Midway Island
- Johnston Atoll
- Adak Island

Within each of these four general alternate locations, a specific site was identified as the most promising for both marine mammal and ATOC purposes. Charts showing the ocean bottom contours for the Midway, Johnston and Adak sites are presented in Figures 2.2.3.1-1 through 2.2.3.1-3. A chart showing the ocean bottom contours for the proposed Kauai location is presented in Section 1, Figure 1.1.6-2.

Of the four potential source sites, Kauai proved to best meet the stated criteria, and the Johnston Atoll site was second best. The Midway Island and Adak Island sites were eliminated from detailed analysis as being unsuitable for both the marine mammal research and ATOC feasibility components of the project. The Kauai site is further analyzed as Alternative 1, and the Johnston Atoll site is carried forward as Alternative 3.

The specific Kauai location was selected based on the following criteria: 1) good acoustic views toward high latitude receivers, 2) 850 m source depth, and 3) greatest distance from shore meeting these first two criteria. By locating the source further offshore, potential impacts on the most abundant great whale in the area, the humpback, are minimized.

The following discussion evaluates each of these four alternative project sites in relation to the MMRP and ATOC project siting criteria identified above.

2.2.3.2 Evaluation of MMRP Source Site Selection Criteria

Table 2.2.3.2-1 summarizes the MMRP source site selection criteria for all four potential project sites and is discussed in more detail in the following paragraphs.

Kauai

One benefit of the north shore of Kauai site, with respect to the MMRP objectives, is the wide range of marine animal species present in the region and, relative to the other potential project sites, there are relatively good baseline data for a number of these species, particularly

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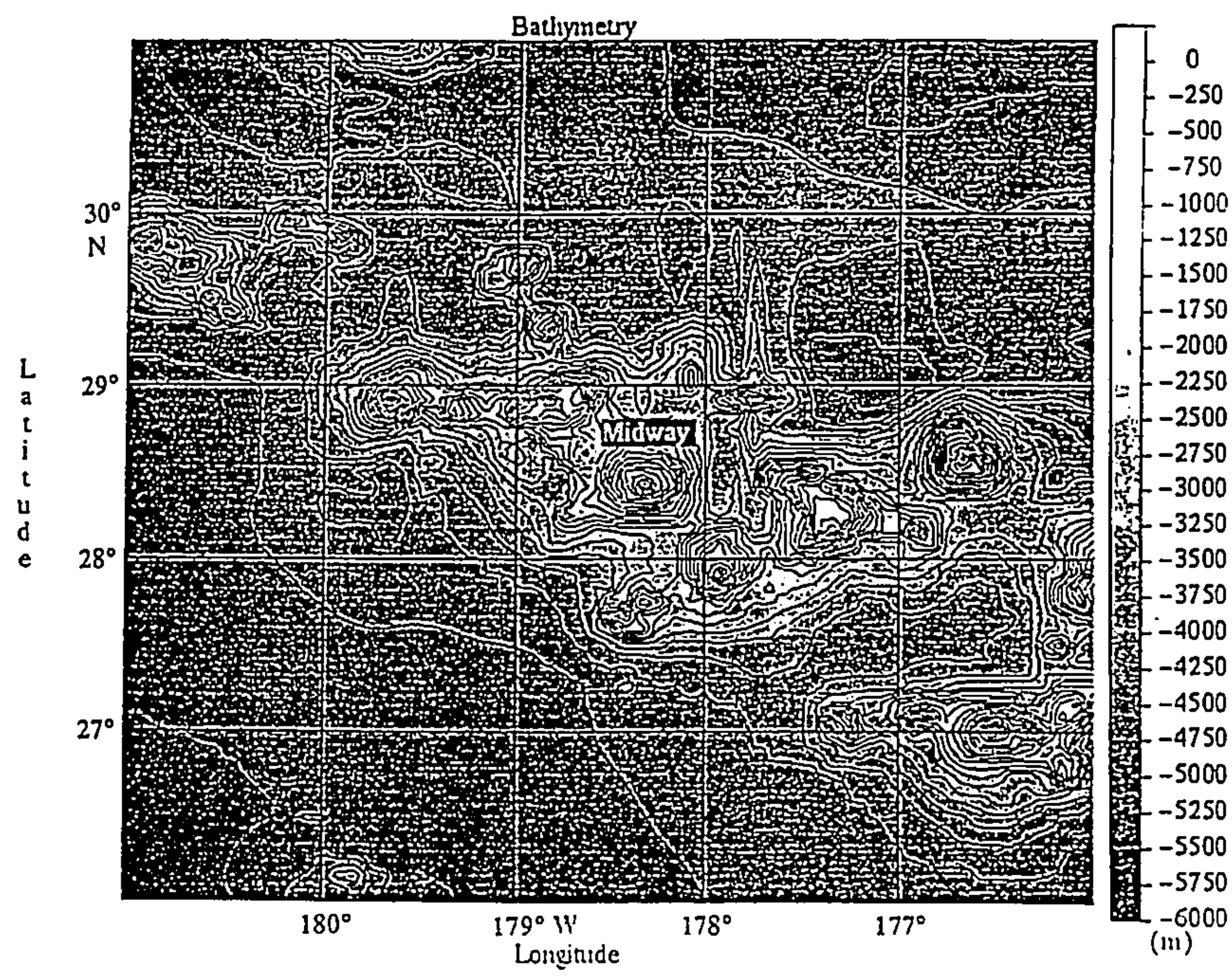

Figure 2.2.3.1-1 Midway Island alternate site seafloor contours

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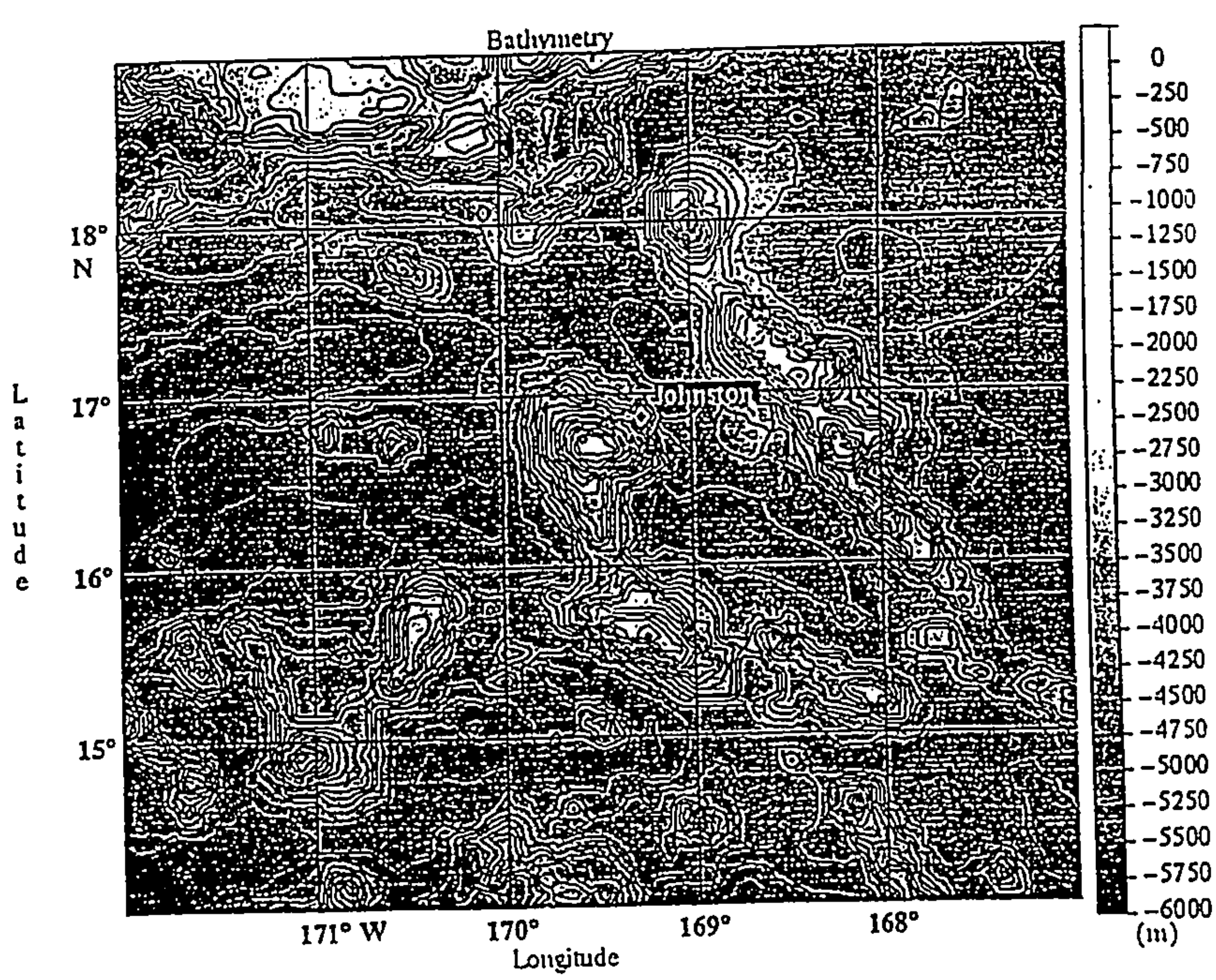

Figure 2.2.3.1-2 Johnston Atoll alternate site seafloor contours

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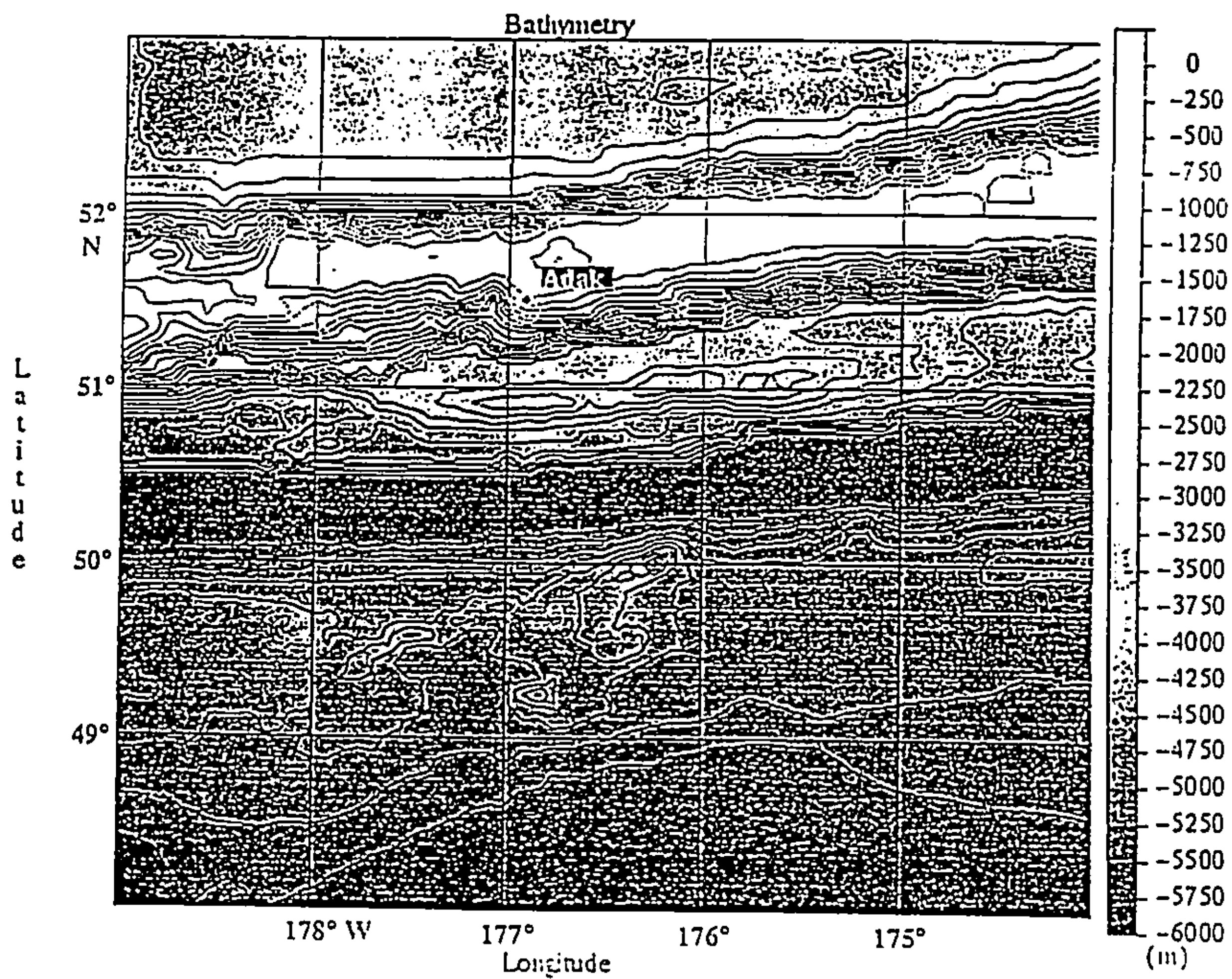


Figure 2.2.3.1-3 Adak alternate site seafloor contours

SITES EVALUATED	Sufficient Marine Animal Populations to Acquire Adequate Data for Meaningful Statistics Weighting Factor (5)	Baseline Marine Animal Population Estimates Available for Area (3)	Close to Land for Aerial Surveys, Vessel-Based Visual Observation and Acoustic Measurements (4)	Close to Other Noise Sources to Allow Comparative Analyses of Effects on Animals (2)	Meteorological/ Oceanographic Conditions Conducive to At-Sea Data Collection (3)	RELATIVE SCORE
KAUAI (14 km/ 8 nm)	H	H	H (<50 km to airport)	M	H	160
MIDWAY ISLAND (110 km/ 59 nm)	M	L	L (>90 km to airport)	L	H	64
JOHNSTON ATOLL (37 km / 20 nm)	M	L	H (<50 km to airport)	L	H	100
ADAK ISLAND (46 km / 25 nm)	H	L	M (>50 km to airport)	M	L	86

Relative Criteria Fulfillment: H = Fulfills Criteria >90%
M = Fulfills Criteria 50%-90%
L = Fulfills Criteria <50%

Note a: Relative Score Criteria: H = 10; M = 5; L = 1
Note b: Weighting factor based on relative importance to achieving program objectives.
Note c: Relative Score determined by multiplying relative score criteria values by weighting factor, then adding the six results for each site.

Table 2.2.3.2-1 MMRP source site selection criteria.

humpback whales. This would allow the MRT to observe these animals for any potential behavior changes attributable to the sound transmissions, and to develop meaningful statistics based on their observations.

Since the proposed site is only 14.7 km offshore, shore-based visual observations of the area have proven very effective. Aerial surveys and observations from small planes, and acoustic signal level measurements off small boats are easily accomplished from Kauai.

The Kauai site also has a number of other noise sources in the vicinity which can be compared to the ATOC source for any impact on marine species. Although no major port is located nearby, there are numerous opportunities to detect, classify, track and measure noise from whale-watching boats, fishing boats, pleasurecraft, recreational power boats, and low-flying aircraft.

Midway Island

Marine species are less abundant and less diverse at the Midway Island site. Therefore, researchers would collect less data on which to base quantifiable statistical analyses. Humpback whales rarely venture as far west as Midway, and the paucity of other species, compared with Kauai, can be attributed to the fact that Kauai is close to the other major islands in the Hawaiian archipelago, which have additional shallow water areas to support coral growth and marine animal feeding grounds. Because Midway is the westernmost inhabited island in the northwestern Hawaiian Islands, no coastal projects have been initiated of a scale large enough to warrant any dedicated marine animal species baseline studies. The closest location off Midway that would support a source from an acoustic and engineering standpoint is approximately 110 km offshore, eliminating the potential for shore-based observations, and severely diminishing the potential for aerial and small boat observations and surveys. The opportunity for collecting noise data from sources other than ATOC would be negligible in this location, as there is minimal ship, boat and aircraft activity on and off the island.

Johnston Atoll

Based on very limited baseline marine animal population estimates available, Johnston Atoll would be expected to have both resident and transient marine animal densities that would offer the opportunity to collect some quantity of meaningful data on the potential effects of low frequency sound on different species. However, the abundances of these species would not be expected to be as great as those off the north shore of Kauai, particularly the primary indicator species, the humpback whale (see Section 3). Thus, the possibility of acquiring quantifiable data sets that could be used in viable statistical analyses must be scored only as medium. Assuming the source site selected via bathymetry data analysis would prove to be adequate from an engineering standpoint, the distance to the air field and port facilities would be less than 50 km, which would facilitate aerial survey work, vessel-based visual observations and acoustic measurements from a boat. The low level of local vessel and low-flying air traffic in the vicinity of the alternate site minimizes the opportunity for comparing potential effects of all sources of local low frequency sound on the atoll's marine life. Meteorological and oceanographic conditions would be comparable to Kauai and Midway; i.e., conducive to at-sea data collection efforts. There is no pre-deployed hydrophone array available off Johnston Atoll for passive acoustic detection of marine mammals and other noise source monitoring.

Adak Island

Based on limited baseline marine animal population data available, the Adak Island area supports both resident and transient marine animal resources that should allow acquisition of adequate data on which to base meaningful statistic analyses. The drawback would be that nay MMRP activities would, in effect, be the starting point for the necessary data bases. Assuming the source site selected via bathymetry analysis would prove to be adequate from an engineering standpoint, the distance to airport and vessel harbor facilities would be just over 50 km away, which would not be as convenient as Johnston Atoll or Kauai as far as aerial survey tasks, boat-based visual observations and boat-based acoustic measurements. Adak Island rates equal to Kauai relative to the proximity of other noise sources that would allow comparative analyses of the potential effect of low frequency sound on marine animals. This alternate site is most likely to be affected by inclement meteorological and oceanographic conditions during the winter months, which would effectively preclude almost all boat-based MMRP activities and, quite often, aerial surveys as well. Although there are a number of SOSUS arrays deployed off the Aleutian Island chain, there would be none available in the vicinity of the proposed source site that could be used for passive analysis of marine mammal vocalizations and ambient noise monitoring.

In summary, Table 2.2.3.2-1 indicates Kauai would be the preferred alternative from a marine animal research viewpoint. However, both Kauai and Johnston Atoll are carried forward into Section 3 and 4 of this EIS for detailed evaluation of alternatives.

2.2.3.3 Evaluation of ATOC Source Site Selection Criteria

This section discusses source site selection criteria for the four potential project sites with respect to proposed ATOC feasibility actions. Table 2.2.3.3-1 summarizes the results; amplifying information is provided in the following paragraphs.

Kauai

The deep sound channel axis is located at approximately 1000 m below the surface in the sub-tropical seas, which includes both Kauai and Johnston Atoll. Since the source location at this site is at approximately 850 m depth there should be excellent coupling of the source energy into the sound channel.

One of the key siting criteria for ATOC feasibility purposes is the number of receiving locations that can be "viewed" acoustically from the source location. These acoustic views are presented in the form of computer-generated "shadow plots" that depict the acoustic "shadows" caused by blockages such as islands, seamounts and other features of the intervening sea bottom. Features as deep as 1000-2000 m below the axis of the sound channel can be

SITES EVALUATED	Deep Sound Channel Axis Weighting Factor (5)	Clear Acoustic View (5)	Seasonal Variation (1)	Site Locally Flat (2)	Site Steeply Sloped (3)	Minimal Cable Armor & Trench. Reqmts. (2)	Good Bottom Properties (2)	Minimum Bottom Currents (2)	Minimum Cable Run to Shore (5)	Close Logistic Support (5)	Use of Existing Tech-nology (no major Eng.) (4)	Minimal Risk to Cable from Bottom Fishing (3)	Poten-tial for Low Env. Conse-quence (5)	RELA-TIVE SCORE
KAUAI (14 km/ 8 nm)	H	H	H	H	H	H	H	H	M	H	H	M	M	375
MIDWAY ISLAND (110 km/ 59 NM)	H	M	M	H	M	L	H	H	L	L	H	H	H	272
JOHNSTON ATOLL (37 km / 20 NM)	H	L	L	H	H	M	H	H	M	L	H	H	H	291
ADAK ISLAND (46 km / 25 NM)	L	L	L	H	H	L	H	L	M	L	H	L	M	183

Relative Criteria Fulfillment:
H = Fulfills Criteria >90%
M = Fulfills Criteria 50%-90%
L = Fulfills Criteria <50%

Note a: Relative Score Criteria: H = 10; M = 5; L = 1
Note b: Weighting factor based on relative importance to achieving program objectives.
Note c: Relative Score determined by multiplying relative score criteria values by weighting factor, then adding the twelve results for each site.

Table 2.2.3.3-1 ATOC source site selection criteria.

significant, since key acoustic modes reach these depths and temperature measurements at these depths are expected to be important. Figure 2.2.3.3-1 is a 200 m-depth shadow plot for this site. The white "spokes" represent those areas that would be in an acoustic shadow. Kauai offers the best possible transmission path coverage to all existing North Pacific receiver positions, including an important site at Guam.

As with the other sites, Kauai is in the northern hemisphere, it also would have a large seasonal variation due to its south-to-north view. The site is locally flat, yet has a 9° slope that is within the desired (>8°) slope range.

Since the Kauai installation takes advantage of an existing cable from shore, it is the only site that would not require armoring the power cable where it comes ashore (due to potential heavy surf conditions and/or rough coral outcrops) or trenching into the bottom (because of heavy surf or high potential for bottom fishing and trawling that could damage the cable). Although the cable run length to shore is 51.5 km the distance of the source from shore is only 14.7 km thereby allowing for close logistic support of a major airport (Lihue). The small boat used for MMRP observations could easily be handled out of Hanalei Bay.

Midway Island

The deep sound channel axis is located at approximately 700 m at Midway, resulting in a good coupling with the source energy. The shadow plot for Midway is shown in Figure 2.2.3.3-2. The Midway site has good path coverage to the eastern Pacific and Guam but paths to two of the Aleutian Islands receivers would be blocked off.

Midway is the only site that does not offer both a locally flat spot for the source and a relatively steep slope seaward of the source. The Midway site is located approximately 110 km (59 nm) from the island, bringing in the question of the feasibility of such a long power cable. Midway is also about 2200 km (1200 nm) from Honolulu, which is the closest major air terminus and vessel port.

All four sites can be considered to have good bottom sediment and basement properties that would minimize bottom reflection and refraction transmissions that could block or otherwise interfere with the outgoing transmission paths. The Midway site should not be adversely affected by bottom currents nor should there be any significant impact by bottom fishing.

Johnston Atoll

Like Kauai, the deep sound channel at Johnston is approximately 1000 m deep. However, shadow plots for 500 m and 1000 m below axial depth reveal only approximately 50% of the sound energy transmitted northward reaching receiver sites at Guam, the Aleutians and the U.S. west coast. At 200 m below axial depth (Figure 2.2.3.3-3), the blockages in all directions would render that deep transmission path unusable. The proposed site is locally flat and well sloped, with good bottom properties for relatively predictable acoustic reflection/refraction. Bottom

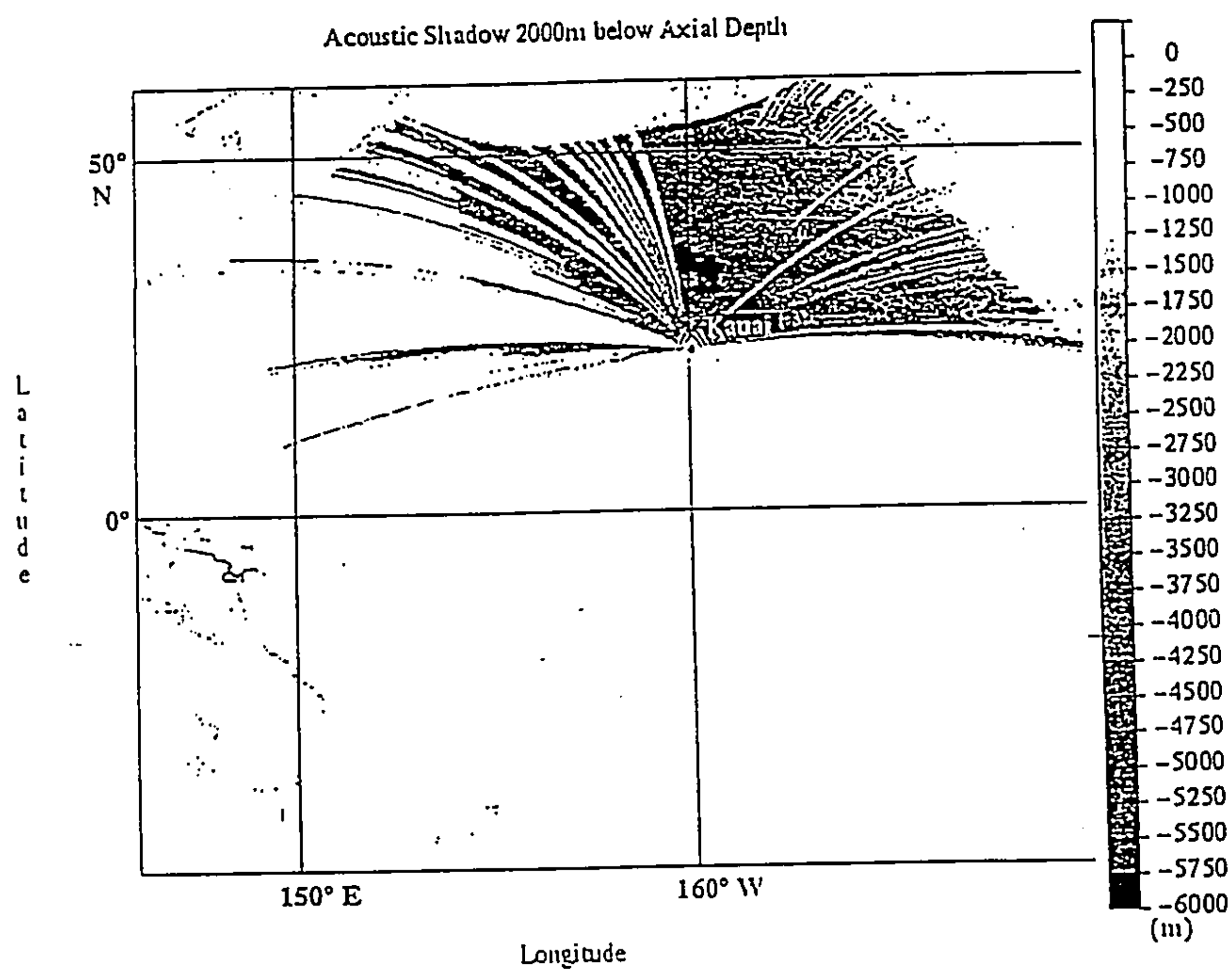


Figure 2.2.3.3-1 Kauai alternate site shadow plot

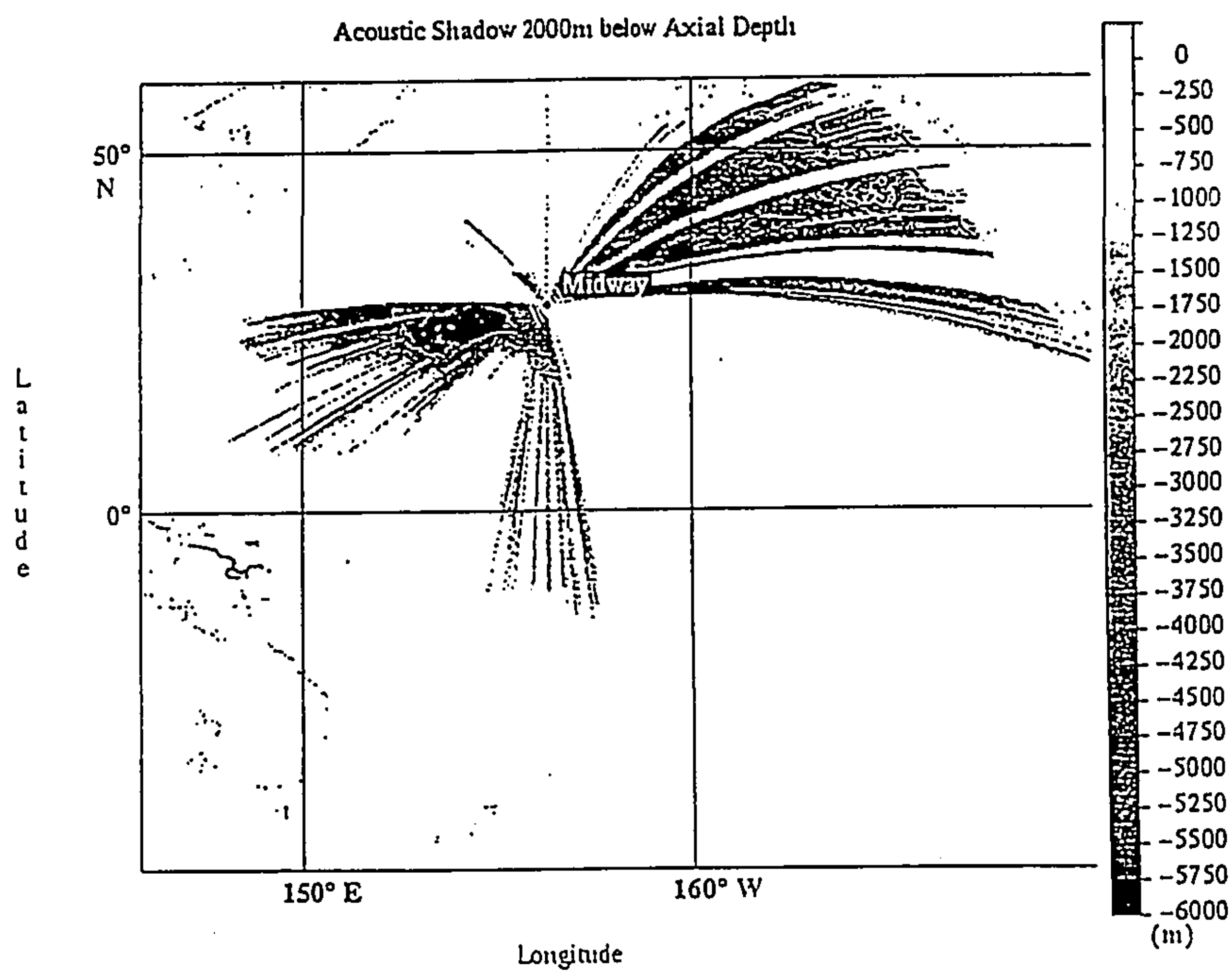


Figure 2.2.3.3-2 Midway Island alternate site shadow plot

currents would be expected to be minimal. Cable run to shore would be approximately 37 km, which generally equates to Kauai and Adak. However, the cables would require some armoring and/or trenching to protect it from seasonal surf conditions, rough coral outcrops, and bottom fishing and trawling that could cause physical damage. Although the local air field and harbor facilities on the atoll would be relatively close by (for research purposes), the nearest major logistical support is about 1370 km away in Honolulu. Because this site would support a shore-powered source, located on the ocean bottom, no major technical or engineering development efforts would be required.

Adak Island

Because the deep sound channel is at approximately 100 m depth at this latitude, the source would have to be located much shallower than at any of the other alternate sites. This shallow source depth translates to greater potential risk from commercial fishing activities and, likewise, a greater possible impact on resident marine animals from the acoustic transmission. Shadow plots for 500 m below axial depth indicate uninterrupted transmission paths only to Guam and U.S. west coast receiver sites south of 40° N latitude. The shadow plot for 100m below the deep sound channel axis shows no sound rays reaching the west coast of the U.S. Figure 2.2.3.3-4 illustrates that for the water column level 200 m below axial depth, there would be blockage toll potential receiver sites, which would render this deep transmission path unusable. Like the other three alternate sites, it is expected that the specific source location selected would be locally flat, and the very steep slopes (associated with the Aleutian Trench system) would minimize bottom interaction. Because of the shallow nature of the source site location and associated cable run, there would most likely be armoring and/or trenching of the cable required. Based on available oceanographic data for the region, it is believed that of all the alternate sites, this location would have the greatest potential for undesirably high bottom currents. Although the cable run to shore would probably be comparable in length to Kauai and Johnston Atoll, and air field and harbor facilities would be close by at Adak Island (for research purposes), the nearest major logistical support site would be Anchorage, approximately 3500 km away. Because this site would support a shore-powered source, that would be positioned on the seafloor, there would be no major technical or engineering design requirements to overcome prior to installation.

2.2.4 MOORED AUTONOMOUS SOURCE (ALTERNATIVE 4)

This section describes the alternative of using autonomous sources; that is, sound sources which are not attached to shore-based power by cables but are free-standing, powered by large battery assemblies. Such sound sources would be moored to the ocean bottom with weights and held, suspended by floats, at the correct ocean depth.

The principal areas of discussion of the moored autonomous source alternative are technical. Two technical aspects necessary to the development and use of such autonomous sources are discussed in this section: 1) development of the sound source itself, and 2) the engineering necessary to integrate the source and the mooring, and to place and use the source for an extended period of time.

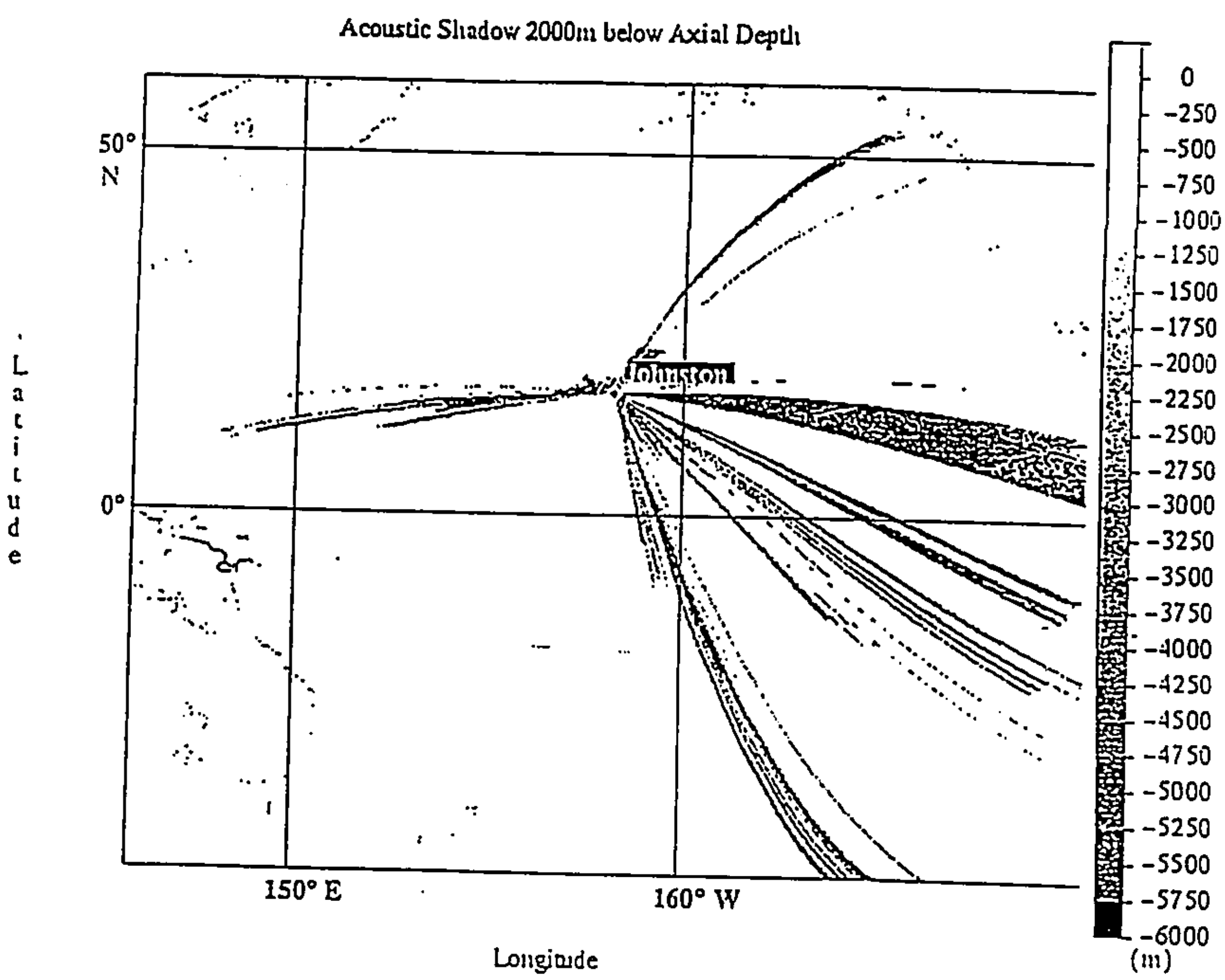


Figure 2.2.3.3-3 Johnston Atoll alternate site shadow plot

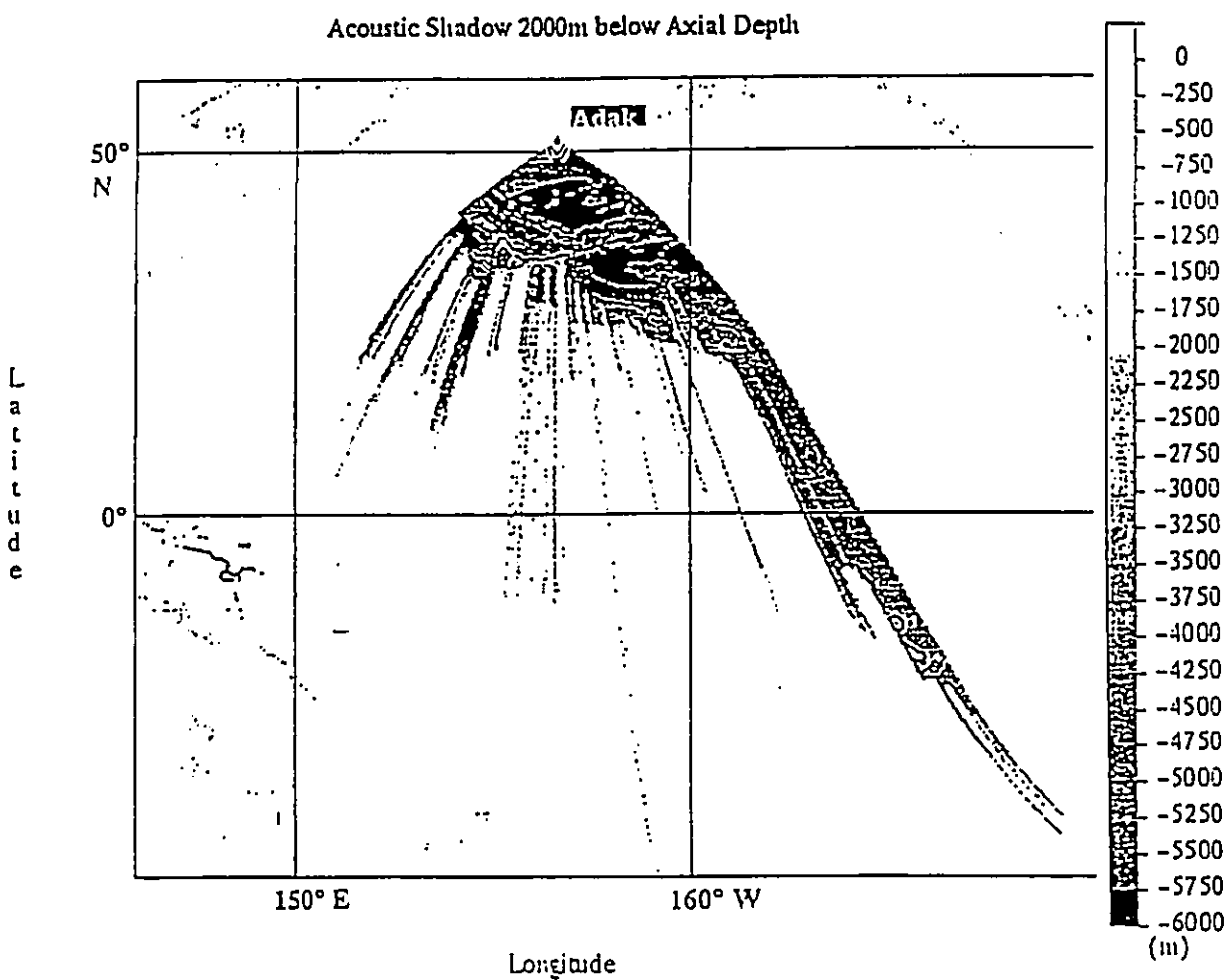


Figure 2.2.3.3-4 Adak alternate site shadow plot

Two different kinds of sources are proposed as ATOC options. The first would be a commercial low frequency projector (HX-556) using bender-bar technology that could deliver source levels up to 197 dB integrated across a 40 Hz bandwidth from 150 Hz to 190 Hz (center frequency 170 Hz). The HX-556 has a built-in active-passive pressure compensation system. This type of source is fairly reliable and could potentially operate up to 2 years, using state-of-the-art battery packs, before planned maintenance would be required. The second source option would be one under development by the Russian Institute of Applied Physics (IAP) that operates by forcing two opposing faceplates with an interior electromagnet. It is reported to be able to deliver source levels up to 197 dB integrated across a 40 Hz bandwidth from 177 Hz to 217 Hz (center frequency 197 Hz). The source would require pressure compensation equipment at depths below 200 m. However, the IAP states that before it can authenticate the autonomous capability of its sound source, it would require additional development of source-driving electronics and amplifiers.

A conceptual moored autonomous source is depicted in Figure 2.2.4-1. There are two deployment problems to solve with the moored autonomous source alternative: 1) high pressure found in the ocean down to 5 km depth; and 2) movement, or wandering, of the source in a circle of up to a 300 m radius around the anchor on the ocean floor. The solution to the first problem would require the design of a robust pressure compensation system in the integration of the source and the mooring hardware. Cornuelle (1983, 1985) has suggested that a solution to the second problem would be to estimate the exact location of the source by analyzing changes in the travel times of sound transmissions from transponders located around the mooring at different inclination angles to the source itself. This solution would require a mooring electronics package which would include a transponder navigation system, time-shift processing unit, transmitter and acoustic transponder where measurement accuracy on the order of 1-2 m is required. Although techniques of tracking underwater moored device motion are relatively mature, they have yet to be applied to large, heavy autonomous sources that would be deployed in the deep ocean.

Several of the different source types potentially available for this alternative operate at frequencies higher than the currently proposed cabled source. By transmitting at a higher frequency, potentially increased impacts on toothed whale (odontocete) species could occur, since those species' hearing sensitivity increases with increasing frequency. This concern would need to be addressed in the selection of any moored autonomous source. To date, there have been no sources designed for autonomous operation that operate at 70 Hz or have been demonstrated to operate at pressures found at 750-900 m depth in the ocean. While battery-powered capability is theoretically available, the power levels required to support 20-min transmissions at least a 2% duty cycle for one year are significant. At a transmitter efficiency of 10%, the battery pack would consist of a 2.8 m^3 (100 ft^3) box filled with Lithium cells and would weigh over 2722 kg (6000 lb). This is 34 times the size of "standard" battery packs used routinely for long-range ocean acoustic experiments.

Because the source would most likely be moored at a considerable distance from the seafloor, the instruments would undergo considerable excursions as the moorings respond to tidal and other deep ocean currents (up to 300 m of movement from vertical has been measured). This

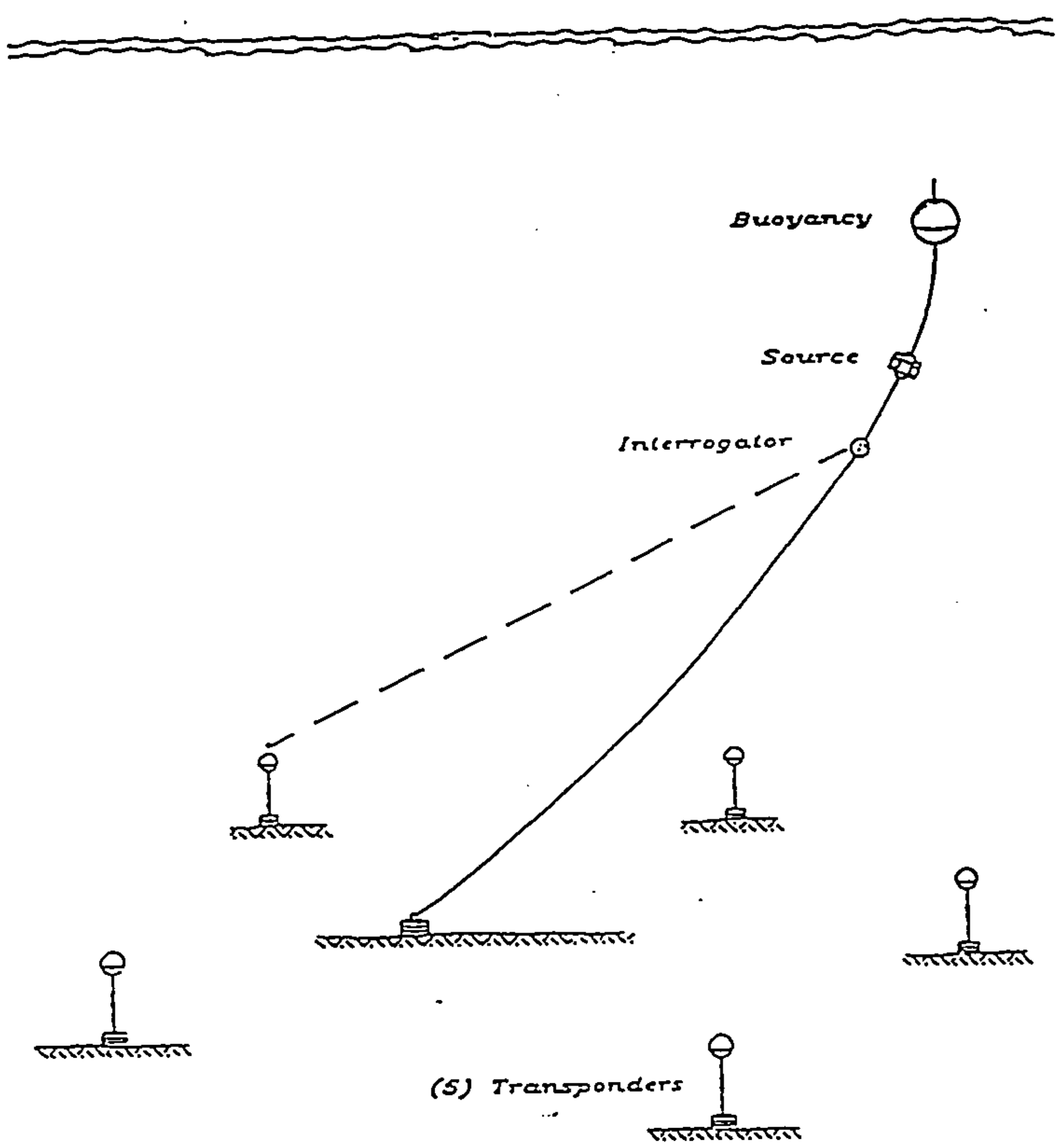


Figure 2.2.4.1-1 Conceptual moored autonomous source

motion complicates interpretation of the received acoustic signal, even if the motion is known exactly, since both distance and path geometry are key determinants in thermometry.

The principal advantage of moored autonomous sources is the increased flexibility in siting opportunities. They can be located where the water depth exceeds the depth of the sound channel. They are not constrained by the logistics of shore-based power cable connections.

On the other hand, most moored autonomous source locations would probably be located some distance from shore, and would create severe logistics problems for any marine mammal research program (e.g., staging facilities for shipboard and aerial observations).

Scheduled maintenance and repair functions on any moored autonomous source, located a great distance from logistic port facilities, would likewise be more costly, time-consuming, and generate more engine hydrocarbon byproducts and noises (from the transiting vessel) than sources located closer to shore.

The design of moored autonomous sources also requires an accurate estimate of required source power levels and duty cycles, since those factors, in turn, dictate battery system requirements. Data provided above on the size of a required battery pack are based on an actual transmitter efficiency of 10%. Achievement of better efficiencies would reduce those requirements.

Due to this potential future applicability, this alternative will be carried forward to be further analyzed and included in the summary of consequences of alternatives.

Table 2.2.4-1 summarizes the advantages and disadvantages of a moored autonomous source.

2.2.5 RESTRICTED SOURCE TRANSMISSION TIMES (ALTERNATIVE 5)

Another alternative considered is to limit sound transmissions to times when vulnerable marine species are not present in the vicinity of the source. This subsection analyzes the feasibility and desirability of this alternative, specifically, in relation to sea turtles and the humpback whale.

Based on available information, it appears that some mysticetes hear at low frequencies and that sea turtles may also be capable of sound detection at low frequencies. Of all the marine animals in the Kauai area, the most reliable baseline data available are on the humpback whale. Their movements throughout the Hawaiian Islands are fairly well understood, and are relatively easily observed from aircraft and shore stations. Their vocalizations facilitate underwater acoustic locating and tracking. Information on the distribution and abundance of sea turtles (particularly deep-diving leatherbacks) in the study area, while not nearly as extensive as that for humpbacks, is available and will be useful in the development of a monitoring program for these species.

Advantages	Disadvantages
• Would avoid problem of acoustic interaction with the bottom which could influence propagation.. • Could potentially be placed in areas of low marine animal activity. • Basic source and battery technology is fairly mature. • Basic mooring and transponder hardware is fairly reliable. • if successful, cost savings over cabled bottom sources could be realized in some situations	• Frequency of proposed sources is as much as 122 Hz higher than desired: - Transmission loss issue (higher TL). - Marine animal issue (higher frequencies are closer to odontocetes' hearing) • New pressure compensation equipment must be designed, developed and field tested. • New source driving electronics and amplifiers must be designed, developed and field tested. • New mooring electronics package (including time-shift processor) must be designed, developed and field tested. • Source wander (up to 300 m) compensation scheme is unproven and would require design, development and field testing. If not fully successful, this would be disqualifying. • Breakdown of large batteries over time could introduce harmful chemicals into marine animals' habitat. • No capability to modify source level, duty cycle, or other operational parameters once deployed. • Technical risks considered to be high because this technique is as yet untried, so no data base exists on underwater operational reliability, service life, or maintenance requirements. • Maintenance and repair would be more difficult and costly than cabled bottom sources closer to land. • If source placement is far from land (in hopes of removing it from as much marine activity as possible), it would render any viable research on low frequency sound effects on marine animals infeasible.

Table 2.2.4-1 Moored autonomous source advantages and disadvantages.

Since the purpose of the proposed MMRP is to evaluate the potential effects of the ATOC sound source on marine mammals and sea turtles, restricting sound transmission times when the humpbacks are present would prevent satisfaction of MMRP objectives.

Restricting source transmission to seasons when humpback whales were not present would also severely damage the validity of the acoustic thermometry climate studies. There is expected to be a large seasonal variation in path-averaged ocean temperature along some of the proposed acoustic paths. To miss winter observations of ocean temperature, by not transmitting, would certainly bias the results of any interannual monitoring. If, for example, the climate change over the next few years resulted in greater extremes (i.e., warmer summers and colder winters) then by sampling summer ocean temperature but not winter temperature, the likely conclusion would be that the ocean was warming. In fact, the annual average extremes would be constant (no climate trend), but missing winter sampling would show a false climatic warming. Properly sampling a cyclic phenomenon, such as the seasonal variation of ocean temperature, requires data to be gathered at all parts of the cycle, in all seasons, to allow underlying climate trends to be detected.

Instead of restricting source transmissions by season, the potential impacts of source sounds on marine animals would be mitigated first through the MMRP Pilot Study, and second by the reduction of source power levels and transmission schedules to the minimum duty cycle necessary to meet the objectives of the feasibility experiment (at the outset, the duty cycle would be only 2%). These mitigation measures are discussed in connection with the following alternative, which discusses Modified Source Operational Characteristics. Section 4 lists the specific mitigation measures proposed to be incorporated into the project.

At some stage during the first year of operations, transmissions must be every day, for two months (8% duty cycle), rather than every fourth day (2%). This period would be deliberately chosen to coincide with the occurrence of the smallest number of marine mammals in the area of the source site. This brief series of transmissions would enable tidal corrections to be made to all subsequent acoustic travel times.

Based on the above, the alternative of restricting source transmissions relative to individual species was eliminated from further analysis and will not be carried forward to the detailed analysis of alternatives.

2.2.6 MODIFIED SOURCE OPERATIONAL CHARACTERISTICS (ALTERNATIVE 6)

A number of scoping comments requested that alternative ATOC source characteristics be considered that could reduce effects on marine mammals. Source characteristics important to potential habitat effects include source frequency (frequencies outside marine animals' communication bands should be preferred), source level (lower power levels are preferred), waveform and pulse length (optimum waveform and coding can reduce the required source levels), and duty cycle (shorter 'on' periods are assumed to have lower potential impacts). Each of these characteristics is discussed below. Generally speaking, the project source has already been designed to optimize these factors, based on present knowledge. Increased understanding resulting from experimental source operations will provide the basis for further optimization.

2.2.6.1 Modified Source Alternatives

The following section explains the critical acoustic parameters and mitigating actions selected for each preferred source characteristic.

2.2.6.1.1 Frequency

Low frequencies are required for acoustic energy to traverse great distances across oceanic sound paths. The frequency of 75 Hz is near the center of the spectrum of deep ocean ambient shipping noise, which peaks 20-30 dB higher than spectrum levels at mid-frequencies (100-1000 Hz) where surface wave noise dominates the acoustic background (Figure 2.2.6.1.1-1). Based on known dominant frequencies of the great whales (Table 4.3.1.1.1-1) it appears that some species produce sound and can hear in this band. Baleen whales use frequencies below and above the proposed source frequency, and toothed whales (odontocetes) use frequencies above the proposed source frequency. Thus, there would be no real benefit relative to potential impacts on marine animal populations by changing the source frequency characteristics. Based on available information, either a higher or lower frequency might be expected to result in increased impacts.

Mitigation Measure A-2: ATOC sound sources would utilize frequencies anticipated to have minimal adverse impacts on species that may be exposed to their acoustic output (i.e., based on available information, either a higher or lower frequency might be expected to result in increased potential adverse impacts).

2.2.6.1.2 Source Level

Figure 1.1.3-2 portrays the source power density spectrum, indicating a peak spectrum power output value of 180 dB. The source is capable of a total power output, integrated across the entire 35 Hz bandwidth, of 195 dB measured at 1 m from the source. This specification of maximum source level was derived by combining the results of the Heard Island Feasibility Test and numerous PE acoustic propagation loss model calculations. It is believed that 195 dB represents the upper limit and optimum source level requirements may end up being lower. The maximum source level would be used during the MMRP Pilot Study only if no significant impacts on marine mammals are observed during its early low-power stages. Further, after the start of ATOC operations, the source level would be adjusted to provide the minimum signal levels required at the receivers.

Mitigation Measure A-3: ATOC sound sources would operate at the minimum power level necessary to support MMRP objectives and feasibility operations.

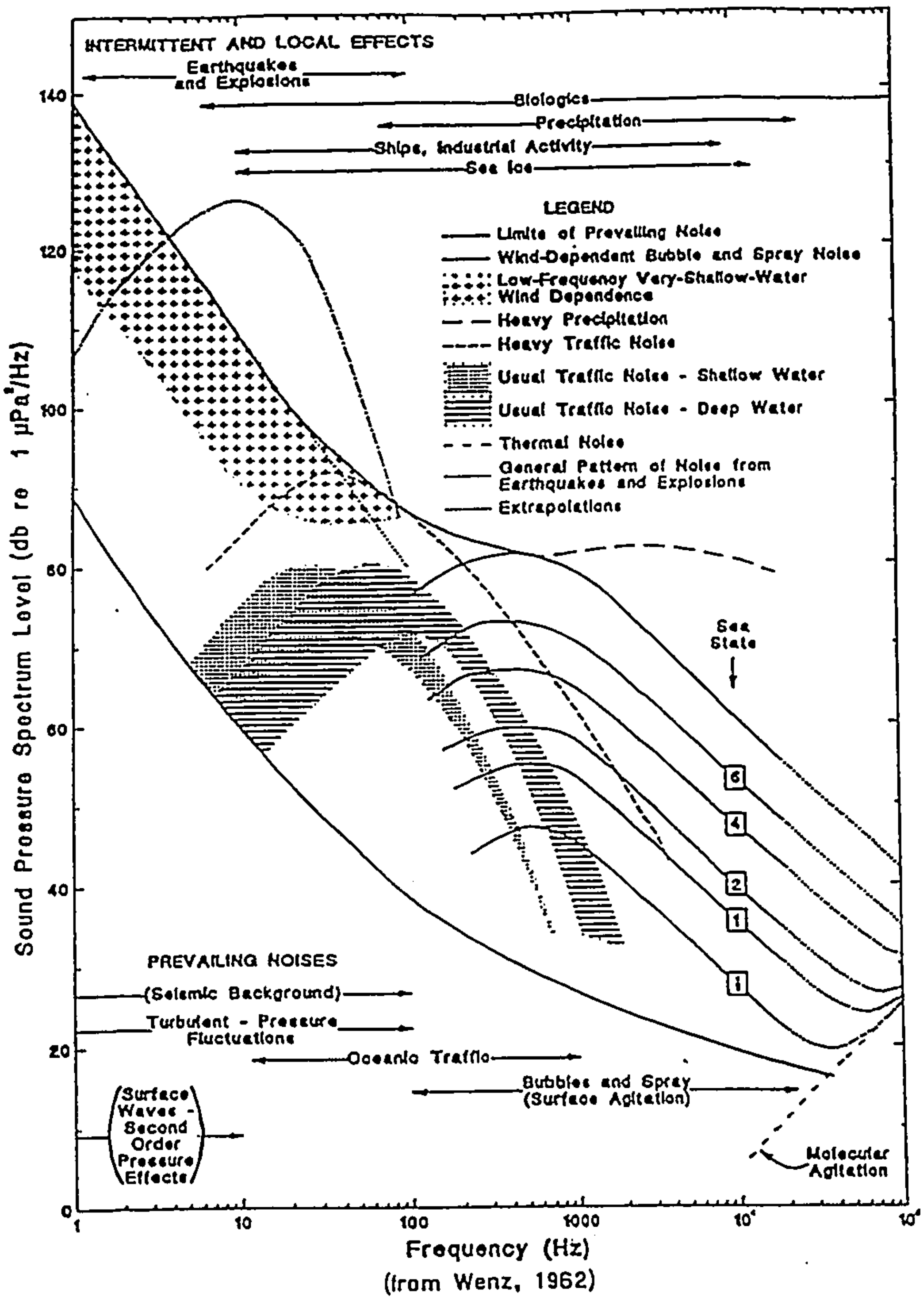


Figure 2.2.6.1.1-1 Ambient noise spectra

2.2.6.1.3 Waveform and Pulse Length

The source waveform has been designed as a digitally coded "M-sequence" and has been optimized for decoding at the receivers. An initial 5 min stepped ramp-up period will help reduce the potential for startling animals and provide them an opportunity to move away from the source. The transmission length of 20 min is designed to spread the energy over time, at much lower source levels, than if the signals were sent as short, loud pulses of the same total energy. While the sounds cannot be "heard" over most of the transmission path distance or at the receivers, they will be detected and timed using advanced digital signal processing techniques, similar to those used by NASA to retrieve data from deep space satellites. Weak but carefully constructed signals of long duration can be extracted from below ambient noise levels. The signal processing technique used at the receivers "stacks" the transmitted energy in order to attain the necessary signal-to-noise ratio for proper data analysis. As a result, the current waveform and repetition protocols are designed to optimize reception, thereby reducing required source power levels to which marine animals would be exposed. Further, studies of migrating gray whales and other marine mammal species (Malme et al., 1983, 1984) indicated reduced sensitivity to intermittent (like the proposed project source) vs. continuous sounds.

Mitigation Measure A-4: The ATOC project would continue to study source waveforms and transmission lengths that may facilitate long-range detection of the source sounds which, in turn, may permit lower source intensities than would otherwise be required.

2.2.6.1.4 Duty Cycle

The proposed ATOC duty cycle would be one transmission every 4 hours (6 per day), for one out of every four days (2% duty cycle). After approximately six months, this duty cycle would be modified for a short period to allow efficient study of the effects of the ocean's daily tidal cycles (8% duty cycle). After about 1-2 months of operation at a 8% duty cycle, it would be reduced to the original 2% to permit required sampling of data received from along the acoustic paths.

Mitigation Measure A-5: Project sound sources would operate at the minimum duty cycle necessary to support MMRP objectives and feasibility operations.

Each source characteristic of the proposed action has been selected for least impact and maximum utility. However, mitigation measures have been incorporated into the proposed action to allow source characteristics to change in response to any observed impacts during the MMRP phase. Additionally, source characteristics will be reduced to the minimum required based on the test period results. Since the ATOC feasibility effort includes all feasible elements of this Modified Source Operational Characteristics alternative, the alternative will not be analyzed separately in the detailed consideration of environmental consequences, but instead should be considered part of the project as proposed.

2.2.7 GLOBAL CLIMATE MODELS (ALTERNATIVE 7)

The alternative of using existing computer models alone to predict long-term changes in the global climate was also evaluated. This section describes global climate models (GCMs) and their limitations. It concludes that the use of computer models alone cannot meet the project objectives because they can only predict, not measure, actual conditions. This section also explains how the ATOC project data would be coordinated with these models to verify their assumptions and projections, and to improve their reliability. Since the use of GCMs is an integral part of the proposed project, rather than a substitute for the project, models alone were not selected as a separate, independent alternative for further analysis.

The ability to numerically model global ocean climate is at a level of development similar to that of weather prediction several decades ago. Modeling of ocean climate presents a greater challenge than numerical weather prediction for two primary reasons. First, significant changes *within* the ocean occur on a much smaller or localized scale than changes in the atmosphere. While atmospheric weather fronts can span thousands of kilometers, significant features of the "weather" in the ocean can be much smaller, on the order of 50-100 km, and are, therefore, more numerous. Thus, much higher spatial resolution is required of ocean models than of their atmospheric counterparts.

Second, in the ocean there is very little pertinent oceanographic data collected for ground-truthing or validating the models. This lack of information has been alleviated somewhat with data from the Geosat-Exact Repeat Mission (Geosat-ERM) altimetric satellite, the European Space Agency's ERS-l satellite (using an altimeter, which measures altitude, and scatterometers, which measure wind speed, and direction, and thus sea state), and the NASA/CNES TOPEX/Poseidon precise altimetric satellite. Sea surface height (SSH) measurements from these satellites help benchmark ocean circulation models. However, direct temperature measurements, in addition to measurement of sea surface height, are critically needed before existing models can gain additional credibility.

The only climatic variation for which there has been some verifiable forecasting capability is the El Niño phenomenon in the Pacific Ocean. There is no such corresponding skill for the Atlantic or Indian Oceans.

Taken individually, observed or modeled data sets could yield inconclusive results. For example, satellite altimetry data are subject to many environmental corrections and errors. The effects of these errors may be magnified by sensor parameter differences between satellites such as Geosat-ERM and ERS-l. The model results alone are not conclusive because they are low resolution simulations that use simplifications of the ocean with respect to physical processes and atmospheric forcing functions. From a practical standpoint, these simplifying assumptions make it possible to run the model on existing super-computers, but if the assumptions are wrong the results likely will be wrong as well or, coincidentally, right for the wrong reason.

The ATOC scientific methodology measures the temperature structure throughout the vertical extent of the sound channel in the water column. The upper and lower limits of the sound channel are defined by the two depths of equal maximum velocity on the profile, between which a velocity minimum (sound channel axis) exists (Urick, 1983). These ocean temperature data collected by ATOC operations in the Pacific will lead to assimilation of that data into Pacific GCMs. In addition, ATOC scientists would work on the interpretation of the best available climate models (Hamburg, Princeton, O'Brien/Hurlburt of Florida State University, Wunsch/Marshall of MIT) under development, in terms of their acoustic signatures, to ascertain how well the GCMs describe the ocean acoustically.

The measurements collected from a Pacific ATOC network would need to be infused into GCM development and validation efforts. If the agreement between real data and a model is poor, the goal would be to improve the physics of the models themselves.

The use of GCMs alone to predict global climate change does not address the project objectives. However, the continued development and verification of GCMs would be an integral part of the overall project. Additionally, ATOC measurements could serve as an essential element of future GCM development. Therefore, this alternative does not meet the programs objective of gathering information on deep ocean temperature measurement and is not analyzed further as a separate alternative.

2.2.8 SATELLITE SENSORS (SEA SURFACE TEMPERATURE MEASUREMENTS) (ALTERNATIVE 8)

Another alternative to acoustic methods of global climate measurements considered is the use of satellite measurements of sea surface temperatures. The discussion below concludes that, while these measurements are fairly accurate for the sea surface, they alone cannot measure global climate changes and, therefore, would not meet the project objectives. However, ATOC research would be coordinated with satellite measurements. Satellite measurement of sea surface temperatures is not a substitute for ATOC, but rather an important adjunct to it.

Satellite sensors offer a number of methods for determining sea surface temperature (SST). All of these methods rely upon measuring microwave or infrared energy emitted from the sea surface. Generally speaking, the most accurate measurements are derived from satellite sensors that sample a number of microwave and/or infrared frequencies. Also important are the algorithms for deriving temperatures from the measurements of electromagnetic energy. These capabilities are constantly being improved.

The best sea surface temperature measurements are accurate to approximately $\pm 0.6°C$, if all available infrared channels are used. Current investigations are concentrating on examining remotely sensed global water vapor data and atmospheric sounder information in order to improve the atmospheric correction factors.

Unfortunately, this wealth of SST information does not reflect thermal properties below the sea surface. Satellite measurements give surface boundary conditions, but due to the impenetrability of sea water to electromagnetic waves (microwaves, infrared), they do not measure temperatures at depth. As a result, there is also a need to monitor the ocean's interior by other means.

ATOC scientists would work closely with ongoing and future satellite data collection programs to extend satellites' ability to measure temperature at the sea surface, into the ocean's interior, by acoustic thermometry. Therefore, this alternative does not meet the programs objective of gathering information on deep ocean temperature measurement and is not analyzed further as a separate alternative.

2.2.9 SATELLITE SENSORS (SEA LEVEL MEASUREMENTS) (ALTERNATIVE 9)

An additional technology for measuring ocean climate changes is the use of satellite-based measurements of sea level. This section explains the accuracy and limitations of this alternative. It concludes that sea level measurements alone, no matter how accurate, are not an effective measure of ocean temperatures. However, satellite sea level measurements are one component, along with ATOC project data, that will be assimilated into the computer predictions of global climate change, which is the ultimate objective of this project. Satellite sea level measurements are not a substitute for ATOC, but instead represent one method of augmenting larger ATOC project objectives.

There are two main reasons why mean sea level rises or falls on long time scales ($\geq$5 years). One is thermal expansion or contraction of a few centimeters in the vertical dimension that is in direct response to changes in the mean temperature of the water itself. The other is the result of variations in the amount of water stored as ice in the polar regions. The latter is by far the larger of the two effects, and accounts for much of the present extent of "drowned" margins of most continents. Another contributing factor in sea level change is earth crustal movement.

Radar altimeters flown in orbiting satellites can measure sea surface height with an accuracy of a few centimeters, so with sufficient sampling repetition, mean sea level can be derived to within about 2 cm. The current limitation on the resolution of satellite altimeters is the degree to which their orbits are known or can be measured. With improvements in modeling and tracking orbits, their precision will certainly increase. However, the underlying enigma is the problem of understanding the extremely complex relationships among atmospheric warming or cooling, oceanic warming or cooling, polar ice cover area and thickness, and sea level rise or fall. Further, in modeling ocean temperatures from sea surface levels, it would be necessary to compensate for the fact that earth crustal movements also change apparent sea levels by comparable amounts.

In order for this alternative to offer any level of viability, concurrent, well-calibrated measurements of polar ice cover and thickness would be needed on the one hand, and sea level rise or fall on the other hand. At this stage, the former is not yet resolved and the latter still an area of active research.

Precise measurements of sea level heights from satellite altimetry sensors would be appropriately incorporated into ATOC oceanographic and acoustic modeling efforts, that would feed into the global climate model prediction efforts. Therefore, this alternative does not meet the programs objective of gathering information on deep ocean temperature measurement and is not analyzed further as a separate alternative.

2.2.10 OCEANOGRAPHIC POINT SENSORS (ALTERNATIVE 10)

All measurements that have been made of ocean temperatures to date have used either remote satellite sensing or conventional thermometers placed directly in the ocean, referred to in this section as oceanographic point sensors.

A number of oceanographic point sensor technologies are in use, the most pertinent of which are expendable bathythermographs (XBTs) and conductivity-temperature-depth (CTD) profiling systems. The ATOC project would use XBTs and CTD/XCTDs in order to validate its own temperature measurements; therefore. this alternative is an element of the ATOC project proposal. However, oceanographic point sensors are not a substitute for acoustic thermometry, due to the extremely large number of such sensors that would be required to provide a comparable level of data.

A component of the ALACE and PALACE systems is capable of ocean point measurements. These are free-floating devices which flow with the current at a specified depth. At programmed intervals they surface, report their position and data, then return to their depth. They provide precise track information and furnish point measurements along a track following ocean currents at depth, but do not provide repeatable path temperature averages, which is the core concept of the ATOC technique.

XBTs are a combined temperature and depth sensing unit with a copper wire connecting them to the surface. They are launched from all sizes of vessels, out of aircraft, and from submarines at depth. As the units sink, they transmit depth and temperature data to the surface. They enable mapping of the temperature pattern of the upper ocean to the standard depth of the T-4 model (460 m), which is most commonly used, or the more expensive models, the T-7 (760 m) or T-5 model, which goes to 1830 m. There are several volunteer ocean observation programs in which XBTs are launched from ships of opportunity along major (and some minor) commercial shipping routes.

XCTDs operate on a similar principle, but add conductivity measurements to determine salinity levels. They are more expensive than XBTs.

XBTs and XCTDs have environmental impacts of their own. Since they are expendable, hundreds of thousands of miles of fine copper wire and tons of zinc and plastic waste have been introduced into the oceans in the form of XBTs and XCTDs. In addition, a program that would expand use of XBTs to the degree required could no longer rely primarily on ships of opportunity.

Furthermore, XBTs are not adequate tools with which to measure climate change in the oceans. XBTs have a temperature accuracy of ±0.15°C and a depth accuracy of ±2%. Climatological researchers expect that the climate "signal," which is swamped by local variability near the sea surface, would be about 0.005°C per year at 1000 m. Thus, the XBTs of today do not meet the requirements of long-term climatological research aimed at addressing questions of global warming. Moreover, merely improving XBT accuracy could not replace acoustic thermometry measurements, since point source measurements are inherently limited in time and space. It is not economically feasible to overcome this limitation by increasing the numbers of launching platforms.

For a dedicated, cost-effective oceanographic program, specialized ships would be required to handle CTD profiling systems. These ships would stop at each sampling station and lower a CTD to obtain salinity and temperature profiles. Each profile typically takes 3-4 hr to complete, thus a single line of point samples across the ocean takes several weeks. The combined resources of tens of nations, each with dedicated oceanographic ships, have not been sufficient to map the global ocean's temperature structure in any detail, and certainly not repeatedly.

XBTs, along with the other oceanographic research tools available, provide complementary forms of data, but cannot be used alone to resolve global climate questions. ATOC is expected to provide instantaneous temperature data averaged on ocean basin scales and would complement, not compete, with the other data collection research technologies. The puzzle of global climate change is sufficiently complex and important to demand the proper integration of all available useful measurement tools. No single technique can answer the outstanding questions of how the oceans are responding to changes in the atmosphere resulting from human activities and natural events (e.g., seismic).

In any event, point source measurements would be taken as part of the ATOC project in order to compare measurements obtained through direct physical measurements with acoustic results.

2.2.11 AUTONOMOUS POLAR HYDROPHONES (ICE NOISE MEASUREMENTS) (ALTERNATIVE 11)

At least one scoping commenter suggested that atmospheric temperature changes could be predicted by listening with hydrophone(s) to Arctic ice noise (J. Lewis, pers. comm., 1994). Lewis suggests that noise levels could be related to the quantity of ice melting, which could then be translated into changing temperatures in the atmosphere.

Correlation between ice noise and air temperature is limited to short-term local changes that are basically unrelated to climate change. It would be extremely difficult to calibrate or quantify any ice noise measurements over a reasonable time period.

In addition, it was suggested that ATOC measure the transmission times of existing noises in the ocean, such as polar ice noises, rather than adding new sources of subsea noise. However, the unpredictable timing, source location and intensity of such noises, and the fact that they are not specially coded for long distance reception nor inserted directly into the sound channel, make their use as a sound source to support acoustic thermometry infeasible.

Listening to Arctic ice noise was not selected as an alternative for further analysis, as it does not address the issue of ocean climate change or present an opportunity for ocean temperature measurements in a scientifically viable manner, and does not meet project objectives.

2.2.12 DUAL SITE EXPERIMENT; ALTERNATIVE MMRP TECHNIQUES -- MOBILE PLAYBACK EXPERIMENTS (ALTERNATIVE 12)

Several commenters suggested that the ATOC/MMRP experiments should be located at two separate sites, with the MMRP being performed using a mobile sound source at a location with relatively large numbers of marine mammals, and the ATOC experiment being performed at a remote location with lower densities of marine animals, without any attempts at associated marine mammal research.

In response to this comment, mobile sound source (playback) experiments have been added to the MMRP at several locations chosen for marine mammal and sea turtle abundances (Hawaii for humpback whales, Azores or Dominica for sperm whales, and Trinidad for leatherback sea turtles). However, playback experiments have only limited relevance to evaluating the potential impacts of an ATOC-like sound source, since they use much lower power levels, they have more pronounced distance/received level relationships (the received sound level from a lower output source closer to an animal varies more quickly as an animal moves in relation to the source), they include the confounding influence of the boat from which the source is deployed, and unless the boat can remain stationary for a long period of time prior to commencement of the experiment (to allow the area to return to steady state), the boat motion diminishes the utility of the data (because the animal could be responding to the motion of the boat; plus the fact that the ATOC source is not mobile). As a result, MMRP experiments utilizing an ATOC-like source are still required, and reasonable abundances of marine mammals are needed to support those experiments.

2.3 RANGE OF ALTERNATIVES AND ALTERNATIVES ELIMINATED FROM DETAILED STUDY

The evaluation of possible alternatives to the proposed project was conducted based on a list of criteria needed to meet project objectives. The suggestions were narrowed to a list of eleven possibilities, including the proposed action and a no action alternative. After further analysis, some of the alternatives were eliminated outright, and some of the features of the suggested alternatives were incorporated into the proposed action. Four alternatives--the proposed action, no action, Johnston Atoll source site and the use of moored autonomous sources--were carried over for further analysis and evaluation. Table 2.4-1 at the end of this section summarizes the analysis of these four alternatives, while Section 4 evaluates their potential environmental impacts. The following is a summary of the alternatives eliminated from further analysis.

2.3.1 ALTERNATIVE 5 (RESTRICTED SOURCE TRANSMISSION TIMES)

Species that could potentially be affected by source transmissions, and which exhibit seasonal presence in mid-Pacific waters are the humpback whale and at least one sea turtle (leatherback). However, as discussed below in Section 4, it is not anticipated that humpback whales would be adversely affected by the source transmissions. Adopting this alternative would eliminate the opportunity to collect research data through a controlled experiment on potential effects of low frequency sound on marine animals conducted by qualified marine biologists..

However, even though this alternative is not analyzed further as a potential alternative, its mitigating effect has been incorporated into the preferred alternative, which includes the reduction of source transmission times.

2.3.2 ALTERNATIVE 6 (MODIFIED SOURCE OPERATIONAL CHARACTERISTICS)

The proposed action calls for source operational characteristics which would minimize potential adverse impacts and optimize project goals. There would be no decrease to any potential impact on marine animal populations by changing the source frequency characteristics. After initial climate studies, the source level and duty cycle would be decreased to the minimum required. Since the mitigating effects of this alternative have already been incorporated into the proposed action, modified source characteristics have not been analyzed as a separate alternative.

2.3.3 ALTERNATIVE 7 (GLOBAL CLIMATE MODELS)

Computer model results alone would be inconclusive because they are a simplification of the ocean with respect to physical processes and atmospheric forcing functions. ATOC temperature measurements would be incorporated into GCMs as benchmarks for verification and validation, with the goal to improve the models' reliability.

2.3.4 ALTERNATIVE 8 (SATELLITE SENSORS--SEA SURFACE TEMPERATURE MEASUREMENTS)

Satellite sea surface temperature measurements would be used in conjunction with ATOC project data to predict global climate changes. SST data do not reflect oceanic thermal properties below the surface. Global warming relies on high latitude convective interchange between the surface and the ocean interior. Satellite SST measurements would be used in conjunction with ATOC project data to provide GCM modelers with data to better predict global climate changes.

2.3.5 ALTERNATIVE 9 (SATELLITE SENSORS--SEA LEVEL MEASUREMENTS)

There is an inherent inter-relationship among atmospheric warming, ocean warming, polar ice cover and sea level change. For this alternative to be viable, coincidental, calibrated measurements of polar ice cover and thicknesses and sea level changes would have to occur on a global scale, which is not currently feasible. However, though this alternative by itself does not meet project objectives, it could be used in conjunction with acoustic thermometry data to further improve GCM models.

2.3.6 ALTERNATIVE 10 (OCEANOGRAPHIC POINT SENSORS)

XBTs (and XCTDs) alone are not the proper tool to measure global climate change in the oceans and therefore do not meet project objectives. This is primarily due to the difficulty of implementing a high-resolution, global sampling plan that would need literally millions of XBTs at a prohibitive cost, but also because of the lack of required measurement accuracy of XBTs. XBT data would be integrated with ATOC measurements, and are therefore incorporated into the preferred alternative and not analyzed further as a separate, independent alternative. Likewise, ALACE and PALACE floats are not considered an alternative to ATOC because they are not able to provide large-scale seasonal and year-to-year temperature variabilities amenable to input to climate prediction model algorithims.

2.3.7 ALTERNATIVE 11 (AUTONOMOUS POLAR HYDROPHONES--ICE NOISE MEASUREMENTS)

Correlation between ice noise and air temperature would be limited to short-term local changes that are basically unrelated to global climate changes. It would also be infeasible to calibrate or quantify ice noise measurements over a long time. Therefore, this alternative would not meet project objectives.

2.3.8 ALTERNATIVE 12 (DUAL SITE EXPERIMENT; ALTERNATIVE MMRP TECHNIQUES -- MOBILE PLAYBACK EXPERIMENTS)

Mobile playback experiments alone cannot adequately study potential marine mammal and sea turtle responses to ATOC-like sound transmissions which, unlike the equipment used in those experiments, use a fixed, high intensity source that is not associated with boats or other human activities. To the extent that this alternative is feasible, it has been added to the proposed project by including playback experiments in the MMRP, it therefore will not be analysed as a separate alternative.

2.4 SUMMARY OF RELATIVE RESPONSE OF ALTERNATIVES TO OBJECTIVES

The relative response of the alternatives to the marine animal research and acoustic thermometry research criteria are key elements in distinguishing among the alternatives. The information in Table 2.4-1 supplies the relative response of the alternatives to the marine animal research criteria and the acoustic thermometry program criteria. Table 2.4-1 assumes that the MMRP described in Appendix C would be carried out in support of Alternative 1; if Alternative 3 or 4 were selected, the table assumes a MMRP research protocol of comparable adequacy would be executed at that site. The percentage values are based upon criteria fulfillment requirements deemed necessary by both marine mammal biologists and acoustic oceanographers associated with the program.

CRITERIA	Alternative 1 (Proposed Action)	Alternative 2 (No Action)	Alternative 3 (Alt. Site-Johnston Atoll)	Alternative 4 (Moored Autonomous Sources)
Marine Mammal Research Program				
• Assess the potential effects of ATOC sound transmissions on the relative distribution and abundance of marine animals (particularly marine mammals and sea turtles) within the 120 dB sound field (modeled at 100 m depth), so as to minimize uncertainties associated with determination of the significance of any effects.	H	N	M	L
• Obtain information to help evaluate what effects the ATOC sound transmissions could potentially have on the relative distribution, abundance and diving behavior of marine mammals and sea turtles.	H	N	M	L
• Identify mitigation measures to avoid the potential disruption of behavioral patterns of local marine animals, particularly marine mammals and sea turtles.	H	N	M	L
• Assess the level of any responses of indicator species to ATOC sound signals, particularly whether any marine mammal or sea turtle demonstrates an acute or short-term response (Table C-1) to low frequency sound transmissions with ATOC source characteristics.	M	N	M	UNK (presume L)
Acoustic Thermometry Program				
• Observe the ocean on the large space scales (3000-10,000 km) which characterize climate, so that modelers will be able to: 1) test their models against the average ocean temperature changes seen by ATOC over a few years, and 2) if, and when, the models prove adequate, use those same observations to "initialize" the models to make meaningful predictions.	H	N	M	H[1]
• Develop and demonstrate the equipment necessary to undertake acoustic thermometry experiments; in particular, reliable low frequency sound sources.	H	N	H	UNK
• Prove the concept of using acoustic thermometry to measure ocean climate variability for global applications by establishing multiple acoustic pathways in the North Pacific.	H	N	M	H[1]
• Obtain early baseline data on transmission times in Pacific pathways to compare with data that may be obtained in a follow-on program, if such a program is approved.	H	N	M	M[1]
• Determine the minimum source level and duty cycle necessary for obtaining valid climatic data.	H	N	M	H[1]
• Characterize oceanographic factors that could affect the global climate "signal," such as tidal cycles, internal wave fields, and mesoscale variations, and determine the constraints they impose on the design of a future (conceptual) ocean monitoring system.	H	N	M	H[1]
• Utilize existing U.S. Navy seafloor hydrophones to the maximum feasible to increase the number of acoustic pathways and, hence, the quantity of data, at a relatively small cost.	H	N	M	H[1]

[1]Assumes that reliable, efficient, safe systems can be developed, tested and deployed successfully.

Relative response criteria:
H = Fulfills criteria >90%
M = Fulfills criteria 50%-90%
L = Fulfills criteria <50%
N = Fulfills criteria 0%

Table 2.4-1. Relative response of the alternatives to the marine animal research and acoustic thermometry program criteria.

2.5 PREFERRED ALTERNATIVE

The preferred alternative is Alternative 1, the proposed action with identified mitigation measures. The MMRP described in Appendix C is tailored for Alternative 1; however, it would be restructured to become an integral part of any other alternative except Alternative 2 (No Action).

3 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This section provides background information for assessing the impacts of the proposed action on the physical, biological, social, and economic environments of the proposed Kauai site and alternate Johnston Atoll site. It provides the framework within which the environmental impacts of the proposed action can be assessed, and also serves as a reference section for the evaluation and comparison of alternative actions. Much of the information presented herein is a compilation of data that were also used during the development stages of the proposed action as a basis for making choices from the range of alternatives.

3.1.1 SOURCES OF INFORMATION

Physical environment information has been compiled from a number of meteorological and oceanographic sources, including the World Meteorological Organization (WMO), the Naval Oceanographic Office (NAVOCEANO), Fleet Numerical Meteorology and Oceanography Center (FNMOC), and the Naval Research Laboratory (NRL).

Biological environment data have been collected from NOAA/National Marine Fisheries Service publications, the Environmental Impact Assessment of Nearshore Marine Life at Princeville, Kauai; a Report on the Development of a Pilot Plant for Ocean Thermal Energy Conversion (OTEC) at Kahe Point, Oahu, Hawaii; The Final EIS for the Johnston Atoll Chemical Agent Disposal System (JACADS); the Final EIS for the Proposed Marine Mineral Lease Sale: Exclusive Economic Zone Adjacent to Hawaii and Johnston Island; the Draft EIS for the Strategic Target System at Barking Sands (U.S. Army Strategic Defense Command); published literature, guide books, letters, and personal communications. Hubbs Sea World Research Institute (HSWRI) and the Honolulu Laboratory of NMFS' Southwest Fisheries Science Center provided information on sea turtles. The U.S. Fish and Wildlife Service provided data on seabird species. Some information on recreation use of the oceans was obtained from the Hawaii Ocean and Marine Resources Council's technical report on Hawaii Ocean Resources Management Plan.

Social and economic environment information has been obtained primarily from the Army Corps of Engineers, the Hawaii Department of Transportation, the National Marine Fisheries Service (Honolulu Office), and personal communications. Some information on recreational activities and revenues from those activities came from the Hawaii Ocean and Marine Resources Council's technical report on Hawaii Ocean Resources Management Plan.

3.2 PHYSICAL ENVIRONMENT

This section addresses the physical characteristics of the alternative site environments that may affect or be affected by the proposed action. A site description is presented first (Section 3.2.1), followed by an overview of meteorology (Section 3.2.2), physical oceanography (Section 3.2.3), water column characteristics including the existing noise setting (Section 3.2.4), and regional geography and geology (Section 3.2.5). Due to the large-scale influence of many environmental features such as currents and winds in the Hawaiian Archipelago and Johnston Atoll areas, much of the following discussion applies to the alternate sites of Kauai, Midway and Johnston Atoll.

3.2.1 SITE DESCRIPTION

The proposed action would take place in Hawaiian waters, with the sound source to be located 14.7 km north of Haena Point, Kauai, at a depth of approximately 850 m (Figure 1.1.5-3). Water depths in the proposed study area range up to 4400 m, averaging approximately 2800 m, with the greatest depths in the northwest region. The 100 m depth contour is approximately 2 km or less from the coast, with the 1000 m depth contour ranging from as far as 19 km (western section of the study area) to as near as 4 km (eastern section) offshore.

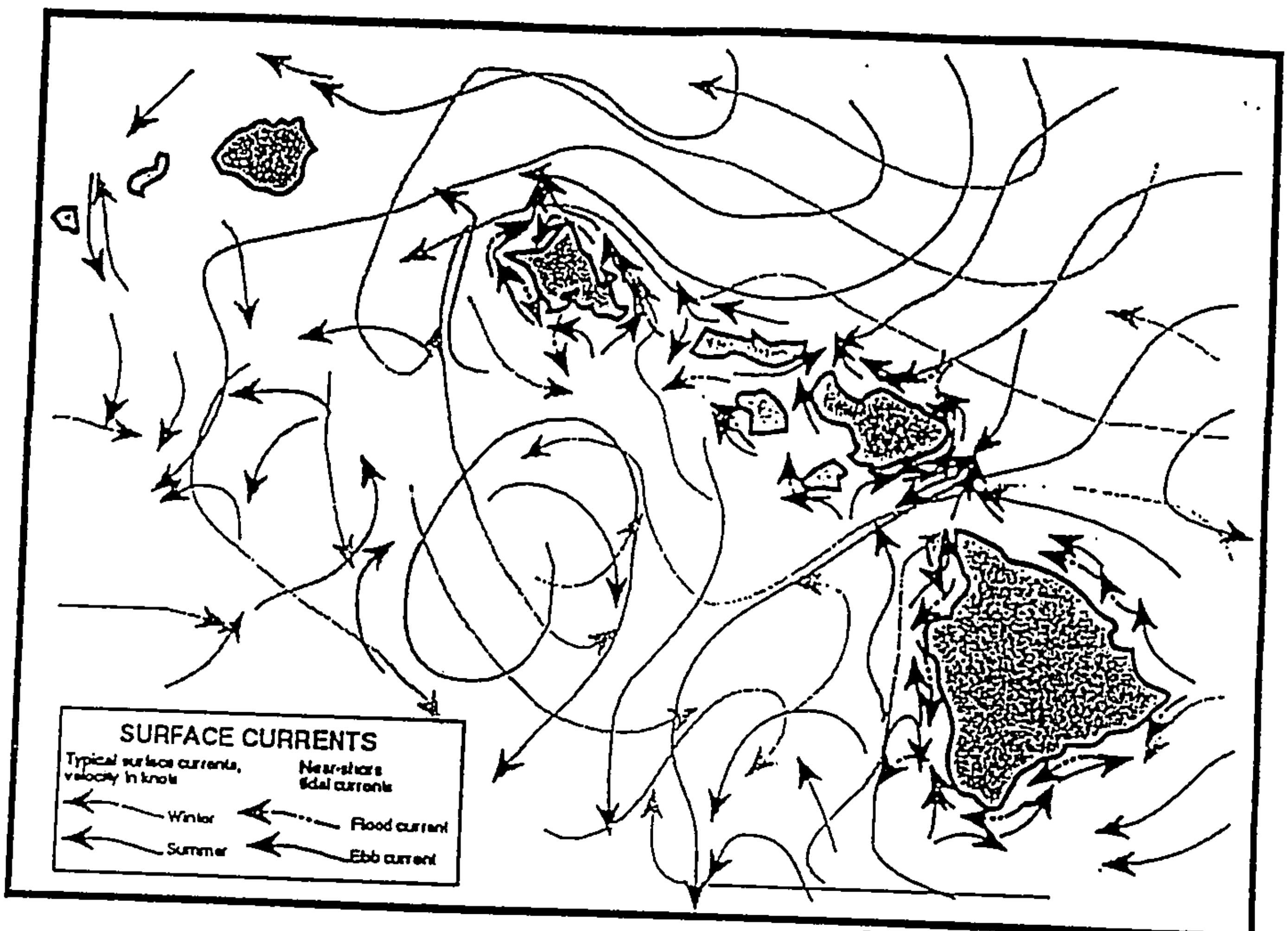
Johnston Atoll consists of two small natural islands (Johnston and Sand Islands) and two human-made islands (Akau and Hikina Islands) totaling approximately 2 km^2 in surface land area (Amerson and Shelton, 1976). The site lies on a 14 by 7 nm (26 by 13 km) coral reef platform in the tropical Pacific. The nearest land to Johnston Atoll is the French Frigate shoals, approximately 450 nm (833 km) to the north-northwest in the northwestern Hawaiian Islands. Honolulu lies 1430 km to the northeast.The atoll was made a federal bird refuge in 1926 by President Calvin Coolidge. Although the oceanic region in which Johnston Atoll lies is relatively unproductive, life on the atoll itself is abundant, with nearly half a million seabirds using it for roosting and nesting (Amerson and Shelton, 1976). Water depths within 50 nm^2 (approximately 130 km^2) of Johnston Atoll are less than 30 m depth. Johnston Atoll differs from most atolls in that the main outer reef extends only one-fourth of the way around its perimeter.

3.2.2 METEOROLOGY

The mid-Pacific region, including the proposed action and Johnston Atoll site, are dominated by tradewinds from the northeast, with wind speeds occasionally reaching 50 kts (92 km/hr) and more (Amerson and Shelton, 1976). During winter months, storms traveling from west to east across the North Pacific can generate severe winds (e.g., > 64 kts [119 km/hr]) and large swells along the north shore of Kauai, up to 5-7 m high. Annual surface wind speeds on Johnston Atoll average 12.7 kts (24 km/hr) (Amerson and Shelton, 1976).

3.2.3 PHYSICAL OCEANOGRAPHY

Predominant circulation patterns of the upper waters of the Pacific (including Hawaiian waters) include a clockwise gyre in the North Pacific and a counterclockwise one in the South Pacific, with an equatorial current system located in between (Pickard and Emery, 1982). Offshore surface currents in the vicinity of the Kauai site are dominated by the North Pacific Current system, generally driven by the tradewinds, running from east-to-west, with average speeds of 0.5-1.1 km/hr (DMAH/TC, 1993). Nearshore currents in the proximity of the proposed action site are predominantly tidal in very shallow waters, with average speeds of 0.7-1.7 km/hr (NMFS, 1991). Figure 3.2.3-1 portrays the general current flow among the Hawaiian Islands.



(from NOAA, 1994)

Figure 3.2.3-1 Hawaiian surface currents

Wennekens (1969) recognized three seasonal flow regimes at Johnston Atoll. One regime (from late November to early March) is characterized by strong southwest offshore currents, while the second regime (early March through mid-June) is generally comprised of a strong northwest, offshore flow. The third regime lasts from mid-June until early December and is characterized by a moderate westward, offshore flow.

3.2.4 WATER COLUMN CHARACTERISTICS

Water column characteristics of greatest importance to the proposed project are temperature, salinity, and ambient noise. Temperature and salinity are important because they affect the properties of the deep sound channel, representing a key consideration for the acoustic thermometry program. Ambient noise levels are important because they establish the background setting for low frequency sound transmissions. Dissolved oxygen (DO) is also considered important because it broadly influences the distribution and abundance of many organisms, particularly bottom dwellers within the oxygen minimum zone (OMZ). The proposed action site and the Johnston Atoll site are located within the OMZ depth range (200 500 m) (Pickard and Emery, 1982). Data for other water quality parameters, including light transmittance, pH, and concentrations of trace contaminants (metals, chlorinated and petroleum hydrocarbons, and radionuclides), for the region of both sites are generally lacking. However, it is highly unlikely that the proposed action will have any demonstrable effect on, or be affected by, these parameters (see Section 4).

3.2.4.1 Temperature-Salinity Properties

In both study areas, typical temperature vs. depth profiles during summer are expected to consist of a surface layer of nearly constant temperature tens of meters thick. Beneath the surface mixed layer is a region of rapidly changing temperatures referred to as the thermocline. Below the thermocline, the water temperature changes gradually with depth, becoming nearly constant again. The depth of the surface layer and the degree of vertical temperature and salinity (density) stratification varies depending on the characteristics and extent of mixing of the various water masses. Surface temperatures in the vicinity of the Kauai and Johnston Atoll sites average 23°C throughout most of the year (Winn et al., 1993). Temperatures between the surface and 400 m depth range from 23-10°C, decreasing to approximately 5°C at 700 m depth (Winn et al., 1993).

Waters near Johnston Atoll range in temperature between 25 and 27°C in the upper 100 m of the water column (Wennekens, 1969). The main thermocline is between 100 and 400 m depth, with temperatures decreasing to nearly 7°C at 400 m. Below 400 m, water temperatures decrease slowly to approximately 2°C at 2000 m. Salinities within 100 m depth range between 34.6 and 34.8 parts per thousand (ppt), with slightly higher values (slightly >35 ppt) between 100 and 200 m depth. At 400 m depth, salinities reach a minimum value of 34.3 ppt.

3.2.4.2 Dissolved Oxygen

DO concentrations are important because they can affect the diversity and abundance of marine organisms. Common features of the DO profiles for 12°N Latitude in the North Pacific are high values (e.g., 4-5 mL/L) close to the surface, a minimum value (e.g., 0-1 mL/L) between 400-500 m, and higher, but still relatively low values at deeper depths (> 2000 m). Although there are no site-specific information available for DO levels off Kauai or Johnston Atoll, the values there are likely to follow similar trends.

3.2.4.3 Existing Noise Setting

Ambient noise is the existing background noise of the environment (Greene, 1991). The following comprise common sources of ambient noise for the study area:

Tidal currents and waves

Wind and rain over the water surface

Water turbulence and infrasonic noise

Biological sources

Human-made sounds (ships, boats, low-flying aircraft).

The ambient noise levels from natural sources are expected to vary according to numerous factors, including wind and sea conditions, seasonal biological cycles, and other physical conditions. Noise levels in the project source frequency band can reach 107 dB from natural sounds alone (Heindsman et al., 1955).

Noise associated with human sources varies with the characteristics of the specific noise source as well as the distance between the source and the alternate sites. The primary human-made noise source within the study area is expected to be associated with ship and vessel traffic. This includes commercial tankers and container ships transiting to and from ports along the Pacific Rim and the west coast of North America, commercial fishing boats and research vessels, military surface vessels, submarines, and aircraft. Vessel noise is primarily associated with the propeller and propulsion machinery. In general, noise levels increase with vessel size, speed, and load. The following indicate estimated upper bounds of broadband noise levels generally within the low frequency band (<1000 Hz) (Urick, 1983; Natural Resources Defense Council, 1994):

Super Tankers (approximately 127 at sea at any time)	187-232 dB
Freighters, bulk carriers, large tankers (approximately 23,000 at sea at any time)	185-200 dB

Tankers, merchant ships (approximately 100,000 at sea at any time)	155-190 dB
Medium-small motor-powered vessels, including fishing boats (hundreds of thousands at sea at any time)	150-160 dB

Noise associated with the passage of vessels and low-flying aircraft is expected to be transient in nature because the sound source typically is moving through the study area. Based on information contained in the Historical Shipping (HiTS) database, the eastern Pacific major tanker shipping lanes have been defined (Figure 3.2.4.3-1). The color code on the right indicates the number of ships per 1000 nm^2 (3420 km^2) on an instantaneous (snapshot) basis. The average density of vessels at any time in the vicinity of the proposed action site is:

Merchant Ships: 0.1 to 0.3
Tankers: 0.05 to 0.18
Large Tankers: 0.003 to 0.005
Super Tankers: 0.002 to 0.003

These densities are based on data between April and August over recent years. Figure 3.2.4.3-2 represents an estimate of tanker traffic for February. The monthly variability in ship densities among the Hawaiian Islands does not change appreciably (i.e., approximately 20-30%).

In 1987, at least 21,325 vessels called at Hawaiian ports, most of which fall in the categories of commercial fishing boats, tanker/merchant, freighter/large tanker, or super tanker. Based on these data, an average of one vessel would be expected to enter or leave a port in Hawaii every 30 min. Thus, a relatively high level of ship traffic can be expected in the vicinity of the study area. The inclusion of military, recreational fishing, and other medium-small size vessels can increase transient noise received levels in the study area to140 dB and higher in the frequency band of the project source. Vessel movements near the Johnston Atoll alternate site are as much as 90% less than in the Hawaiian Islands, with a proportionate decrease in ambient noise levels attributable to such sources.

During the 1994 MMRP survey (January through April), a single hydrophone array monitored ambient noise levels in the water column, at approximately 100 m depth. Spectrum level noise values of 75.8 dB for Beaufort 2 sea conditions (wave height 0.3-1 m) and 97.6 dB for Beaufort 6 (wave heights 1.5-2.4 m) were recorded (Frankel, 1994; in press). Vessels passing within approximately 200-500 m of the hydrophone increased the broadband noise field by up to 22 dB for frequencies < 1000 Hz (97.8-119.6 dB) (Frankel, in press).

The sound frequency and ranging (SOFAR) channel (deep sound channel) corresponds to the depth range in which the speed of sound is at a minimum. At depths shallower and deeper than the SOFAR channel, the speed of sound is relatively greater than the channel due to higher temperatures above and relatively greater pressure below. Because the properties of the channel are related to temperature structure of the water column, the depth of the SOFAR channel varies

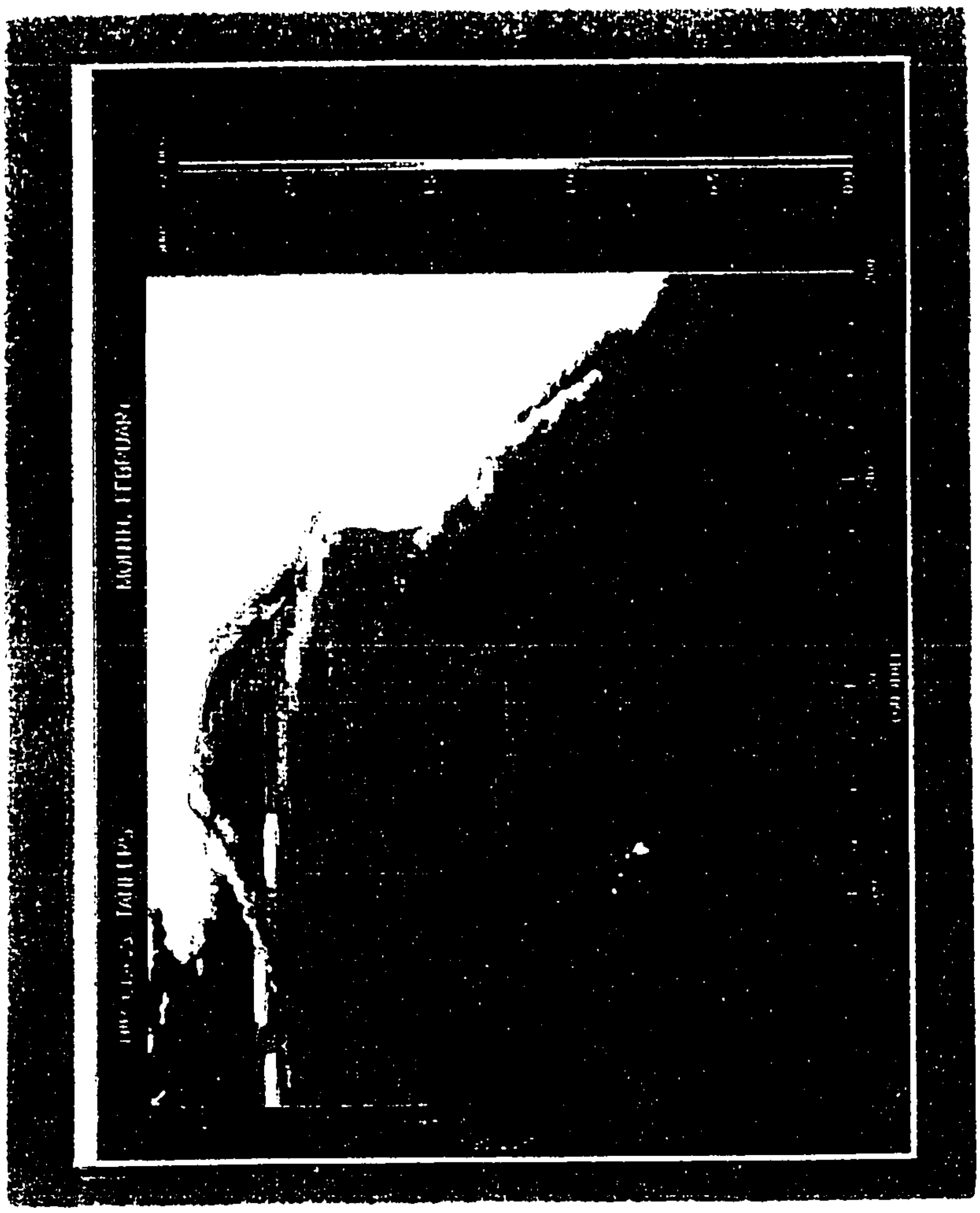


Figure 3.2.4.3-1 East Pacific major tanker shipping lanes (from HITS model, 1994)

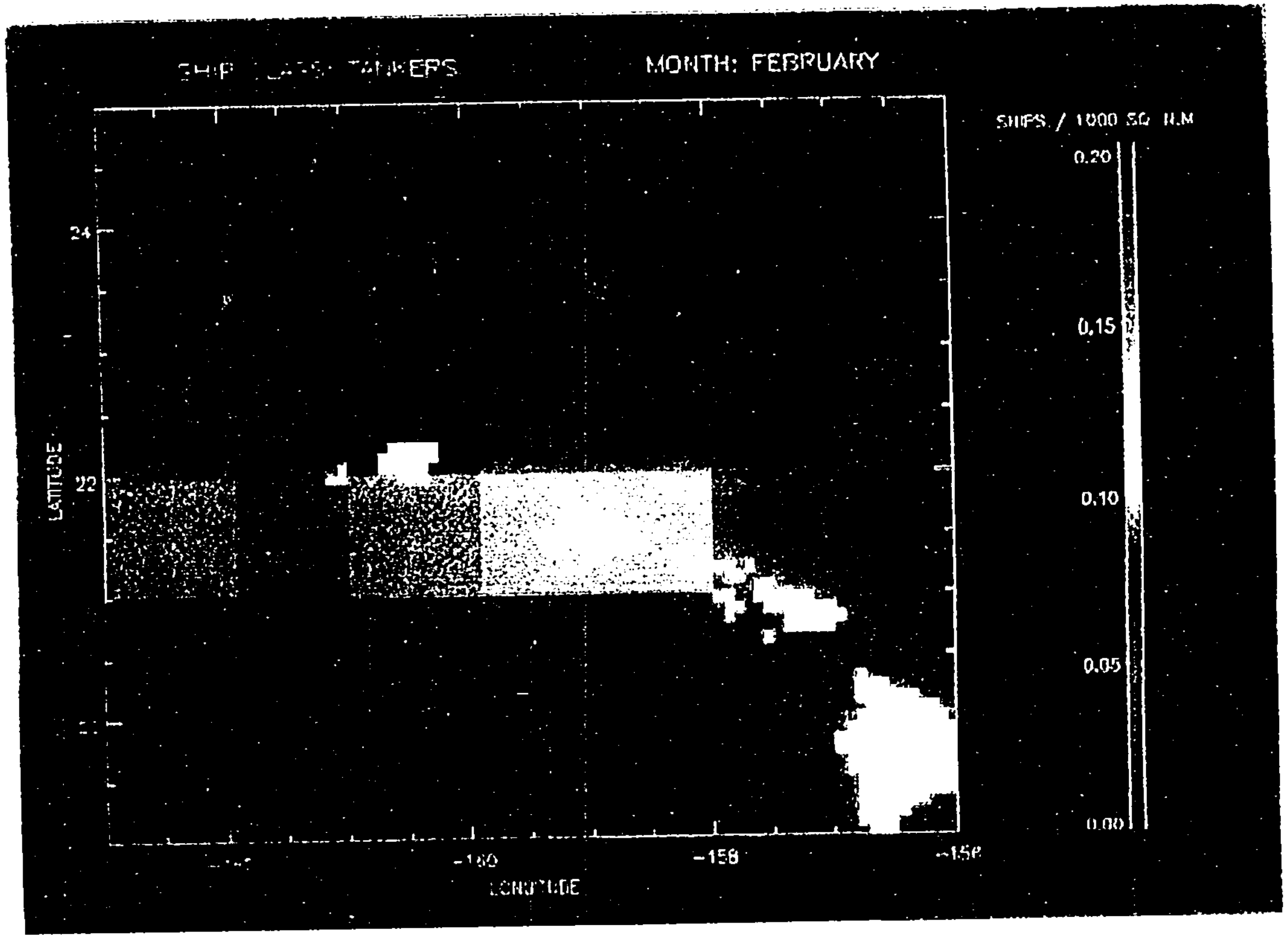


Figure 3.2.4.3-2 Kauai area tanker shipping density (from HITS model, 1994)

with location. In the vicinity of the proposed action and Johnston Atoll sites, the SOFAR channel occurs at depths between approximately 800 and 1000 m.

3.2.5 REGIONAL GEOGRAPHY AND GEOLOGY

Important regional geography and geology features include seismicity and bottom topography; presence and location of large geologic structures such as submarine canyons and seamounts; and bottom conditions. No data exist on sediment physical and chemical conditions, including concentrations of major and trace constituents near the proposed action and alternate sites. However, the proposed action is not expected to affect or be affected by these sediments (see Section 4). A discussion of the geographic and geologic characteristics of the proposed cable routes is presented in Sections 3.3.9 and 1.1.6.

3.2.5.1 Regional Subsea Geography

The primary divisions of the seafloor are the shore, island shelf, island slope, island rise, and deep-sea bottom. The shallow, inshore areas (<25 m depth) at the Kauai site are comprised of a massive reef with outcrops of beachrock which extends for nearly 1 km. The main offshore reef, which is comprised of coral rubble and coarse sand extends offshore in depths between 25 and 30 m (SSI, 1993). Seaward of the coral rubble, large sand ripples extend offshore for nearly 2200 m at water depths between 30 and 45 m. The exposed reef (between 45 and 67 m depth) is dissected by frequent surge channels. On the steep shallow slope area (the outer reef between 85 and 215 m depth), the heads of numerous debris flow channels, canyons, and major submarine slumps are found around the island.

Similar to Kauai, Johnston Atoll consists of coral reef habitats in shallow nearshore areas (Amerson and Shelton, 1976). A marginal reef, exposed only at low tides, extends for nearly 9 nm (17 km) along the northwest margin of the atoll. A broad shallow ridge extends from the west end of the marginal reef, with Johnston, Sand, and Hikina Islands lying on this reef. A depression (nearly 30 m in depth) of nearly 5 nm^2 (17 km^2) in area lies in the extreme eastern part of the atoll. Although no specific information is available on geomorphology offshore of Johnston Atoll, island shelf and slope habitats extend beyond the main outer reef and would include the proposed sound source area of this alternate site.

3.2.5.2 Seismicity

Seismic activity in the Hawaiian Islands is concentrated in the vicinity of the active volcanoes on the island of Hawaii (SSI, 1993). Some earthquakes are related to tectonic subsidence of the islands, with most of this activity also surrounding the island of Hawaii. Generally, seismic activity in the vicinity of both Kauai and Johnston Atoll sites is expected to be minimal.

3.2.5.3 Bottom Conditions

The sea bottom at the proposed Kauai site is composed of mixed sand, coral, and basalt throughout. Coral and sand predominates in shallow, near-shore waters of less than 100 m depth. In water depths ranging between 45 and 67 m, the exposed reef is dissected by large sand-bottom surge channels. Erosion-based basaltic sediments are found as water depth increases, with large sand ripples on the western edge of the shelf off Kauai (SSI, 1993).

Similar to Kauai, bottom conditions at Johnston Atoll are dominated by coral, sands, and rubble. The inner reefs are composed of corals and mixed sand, while sandy bottom begins to predominate beyond the outer reef and into the island shelf and slope areas (Amerson and Shelton, 1976).

3.3 BIOLOGICAL ENVIRONMENT

This section describes the biological environment within or in the general region of the alternate sites, depending on data availability. Separate sections are presented on marine mammals (3.3.1), sea turtles (3.3.2), fish (3.3.3), invertebrates (3.3.4), plankton (3.3.5), seabirds (3.3.6), threatened, endangered, and special status species (3.3.7), marine sanctuaries and special biological resource areas (3.3.8), and cable route biota (3.3.9).

3.3.1 MARINE MAMMALS

This section provides information on marine mammals residing in, or passing through, the study region. Eighteen marine mammal species, including four baleen whales (mysticetes), sixteen toothed whales (odontocetes), and one pinniped may reside permanently or occur seasonally to rarely within the region (Table 3.3.1-1). Species in the following sections are listed first by common and Hawaiian names (when available) and then by scientific names.

Mysticete and odontocete sightings within 35 km of the proposed Kauai site during the Marine Mammal Research Program (MMRP) aerial surveys during February-March 1993 and January-May 1994 are presented in Appendix F. Results of these aerial surveys indicate that humpback whales are one of the most abundant marine mammals in the study area, with a total of 397 individuals being sighted in 1993. A total of 525 spinner and spotted dolphin (*Stenella* spp.) were recorded, as well as 67 pilot whales. Similar results were found during 1994 aerial surveys by MMRP researchers: a total of 232 humpback whales were observed during these surveys, with 295 spinner/spotted dolphin, 160 pilot whales, and 82 bottlenose dolphin also being recorded. Observational data from the two shore stations in 1994, Albatross (SS1) at Princeville (47 m height), and Kalalau (SS2) on the Kalalau Trail (140 m height) are also presented in Appendix F. At SS1, 319 humpback pods, totalling over 500 individuals were observed. At SS2, 382 humpback pods, totalling nearly 700 individuals were recorded. Additional data on single adults and number of pods with number of adults also is presented.

SPECIES	NUMBER SIGHTED DURING 1993 AERIAL SURVEYS	ESTIMATED DENSITY (Note 1) (Note 2)	NUMBER SIGHTED DURING 1994 AERIAL SURVEYS	ESTIMATED DENSITY (Note 1)	COMMENTS
MYSTICETES					
humpback whale (*Magaptera novaeangliae*)	397	0.00573	232	0.00320	Note 3
blue whale (Balaenoptera musculus)	0	0	0	0	
fin whale (B. physalus)	0	0	1	0.00001	Note 4
right whale (Eubalaena glacialis)	0	0	0	0	
ODONTOCETES					
sperm whale (*Physeter macrocephalus*)	4	0.00006	20	0.00027	
pygmy sperm whale (*Kogia breviceps*)	4	0.00006	0	0	
dwarf sperm whale (*Kogia simus*)	0	0	0	0	Note 5
spinner/spotted dolphin (*Stenella spp.*)	525	0.00758	295	0.00407	
bottlenose dolphin (*Tursiops truncatus/gilli*)	77	0.00111	82	0.00113	
rough-toothed dolphin (*Steno bredanensis*)	0	0	35	0.00048	
striped dolphin (*Stenella coeruleoalba*)	0	0	0	0	Note 6
killer whale (*Orcinus orca*)	0	0	0	0	Note 7
false killer whale (*Pseudorca crassidens*)	229	0.00331	0	0	
pygmy killer whale (*Feresa attenuate*)	0	0	0	0	Note 8
short-finned pilot whale (*Globicephala macrorhynchus*)	67	0.00097	160	0.00221	
beaked whales (*Ziphius cavirostris, Berardius bairdi, Mesoplodon spp.*)	5	0.00007	5	0.00007	
melon-headed whale (*Peponocephala electra*)	0	0	0	0	Note 9
PINNIPEDS					
monk seal (*Monachus schauinslandi*)	0	0	0	0	Note 10
SEA TURTLES					
loggerhead (*Caretta caretta*)	0	0	0	0	Note 11
green (*Chelonia mydas*)	0	0	11	na	Note 12
olive ridley (*Lepidochelys olivacea*)	0	0	0	0	Note 13
leatherback (*Dermochelys*)	0	0	0	0	Note 14
hawksbill (*Eretmochelys impricata*)	0	0	0	0	Note 15

Notes (following page) in many cases indicate best estimate of stock when few or no animals were sighted during 1993 and 1994 aerial surveys.

Table 3.3.1-1 Estimates of the stock of marine mammal and sea turtle species present in waters adjacent to the main Hawiian Islands.

Note 1: Density estimates determined by dividing the number of sightings by the total estimated area surveyed (1993-69,216 sq km; 1994-72,576 sq km) (Mobley et al., 1994a; Mobley et al., 1994b).

Note 2: Abundance estimates analyzed separately for each flight produced a range of coefficients of variation (CV) of 0.173-0.390; combining all flights reduced the CV to 0.113 (Mobley et al., 1994a).

Note 3: 74% of humpbacks sighted during 1993 surveys were in water shallower than 200 m (Mobley et al., 1994a); 1994 data analysis incomplete, but majority of sightings were inside the 200 m depth contour (Mobley et al., 1994b).

Note 4: Single fin whale sighting 2/26/94, 37 km off the northwest shore of Kauai (Mobley et al., 1994a).

Note 5: No real estimates of abundance of dwarf sperm whales available (D.K. and M.C. Caldwell, 1989)

Note 6: Based on a conservative (upper bound) estimate of 2,000,000 individuals in the ETP (Holt and Sexton, 1989a, b, 1990; Wade and Gerrodette, 1992), estimated density of 0.06667 is derived (using an approximate ETP area of 30,000,000 sq km).

Note 7: Although reported from tropical and offshore waters, killer whales are more commonly found in colder waters, typically within 800 km of major continents (NOAA-TM-NMFS F/NWC-210, 1991).

Note 8: Widely distributed in ETP, including Hawaiian area and off Japan; however, in no area is the pygmy killer whale described as abundant (Leatherwood and Reeves, 1983).

Note 9: Distributed worldwide in tropical and subtropical waters; specimens and sightings have been reported from the west coast of Central America, Hawaii...; however, only abundant in the Philippine Sea; everywhere else appears to be rare (Leatherwood and Reeves, 1983).

Note 10: No monk seals sighted during 1993-94 aerial surveys. Single opportunistic sighting within the 200 m depth contour occured during 1994 shore observation period (1/30-4/15/94) (Smultea et al., 1994).

Note 11: Among the only central Pacific sightings are from Hawaii; four records from 1979-92 (NOAA-TM-NMFS-SWFSC-186, 1993).

Note 12: Listed as unidentified sea turtles from aerial surveys; however, assumed green turtles based on size and location close to shore (all in <100 m depth). 1994 shore observation period yielded 78 sightings of [presumed] green sea turtles, all inside the 200 m depth contour. Because green sea turtle habitat is primarily in nearshore benthic areas, calculating density based on total area surveyed is not applicable.

Note 13: Olive ridley sea turtles are rare throughout the islands of Oceania. In the central Pacific a single nesting was reported in 1985 on Maui (Balazs and Hau, 1986).

Note 14: Nesting apparently does not occur in Hawaii. Leatherback turtles are regularly sighted in offshore waters (>1000 m deep) at the southeastern end of the Hawaiian Archipelago (NOAA-TM-NMFS-SWFSC-165, 1993).

Note 15: In the Hawaiian Islands, the hawksbill is presently a rare species that is thought to be in immediate danger of local extinction; only known to occur in southern portion of Hawaiian Island chain, mainly in coastal areas of Hawaii, Molokai and Oahu (19 deg N - 22 deg N). More northerly regions of the chain (22 deg N - 29 deg N) appear to be unsuitable habitats for hawksbill residency and reproduction (NOAA-TM-NMFS-SWFSC-165, 1991; NOAA-TM-NMFS-F/SPO, 1992; NOAA-TM-NMFS-SWFSC-186, 1993).

Table 3.3.1-1 Estimates of the stock of marine mammal and sea turtle species present in waters adjacent to the main Hawiian Islands.

Data on marine mammal sightings off Johnston Atoll are limited. Because recent surveys have not been conducted in the vicinity of Johnston Atoll, most of the occurrences have been historical observations. Humpback whales have been reported off Johnston Island (Ludwig, 1982; U.S. Army Corps of Engineers, 1983a); however, Johnston is not known as a major breeding, feeding, calving or otherwise significant biological habitat for any listed, proposed or candidate endangered or threatened species of mammals (DoI/MMS, 1990).

3.3.1.1 Mysticetes

Four species of baleen whale or kohola (blue, fin, right, and humpback) may occur in the Kauai study area. However, only one, the humpback, is known to be present historically in reasonably large numbers and is described in detail herein. Humpback whales (*Megaptera novaeangliae*) are abundant in coastal waters of the main Hawaiian Islands from November through April. Fin whales (*Balaenoptera physalus*) and blue whales (*B. musculus*) could possibly occur in the area; however, their distribution and abundance in the region is believed to be uncommon (Balcomb, 1987). Right whales (*Eubalaena glacialis*) occur rarely in the Hawaiian Islands area (Herman et al., 1980).

Humpback whales occur worldwide in both coastal and open ocean areas, with estimated abundances of 10,000-12,000 individuals (NMFS, 1992). They typically migrate between tropical/sub-tropical and temperate/polar latitudes. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, feeding primarily on small schooling fish and krill (Caldwell and Caldwell, 1983). It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands (Balcomb, 1987; Salden, 1987). Maximum diving depths for humpbacks are approximately 150 m (but usually <60 m) and they may remain submerged for up to 21 min (Dolphin, 1987).

The size of most humpback whale stocks, all of which are endangered, is uncertain. The eastern North Pacific stock, which migrates from Hawaii and Mexico to Alaska and California, respectively, is presently estimated at about 3000+ animals. Trends in abundance in the eastern North Pacific stock off central California indicate upward movement, but this stock has not been studied well enough to assess status, recovery, or habitat impacts (Calambokidis et al., 1990).

Humpback whales occur off all eight Hawaiian Islands, but particularly within the shallow waters of the "four-island" area (Kahoolawe, Molokai, Lanai, Maui), the northwestern coast of the Big Island, and the waters around Niihau, Kauai and Oahu (Figure 3.3.1.1-1) (Baker and Herman, 1981; Herman et al., 1980; Wolman and Jurasz, 1977). The largest concentrations of humpbacks in Hawaiian waters can be found on Penguin Bank west of Molokai (Balcomb, 1987). The whales are generally found in shallow water shoreward of the 200 m (approximate 100 fathom) depth contour (Herman and Antinoja, 1977), although Frankel et al. (1989) reported some vocalizing individuals up to 20 km off South Kohala on the west coast of the Big Island, over bottom depths of 1400 m. Cow/calf pairs appear to prefer very shallow water less than 18 m (10 fm) (Glockner and Venus, 1983). At Kuili off the Big Island, Smultea (1989) found significantly more cow/calf pairs in water <55 m deep. Some results suggest that habitat use patterns of nearshore waters by females and calves near Maui may have changed (decreased),

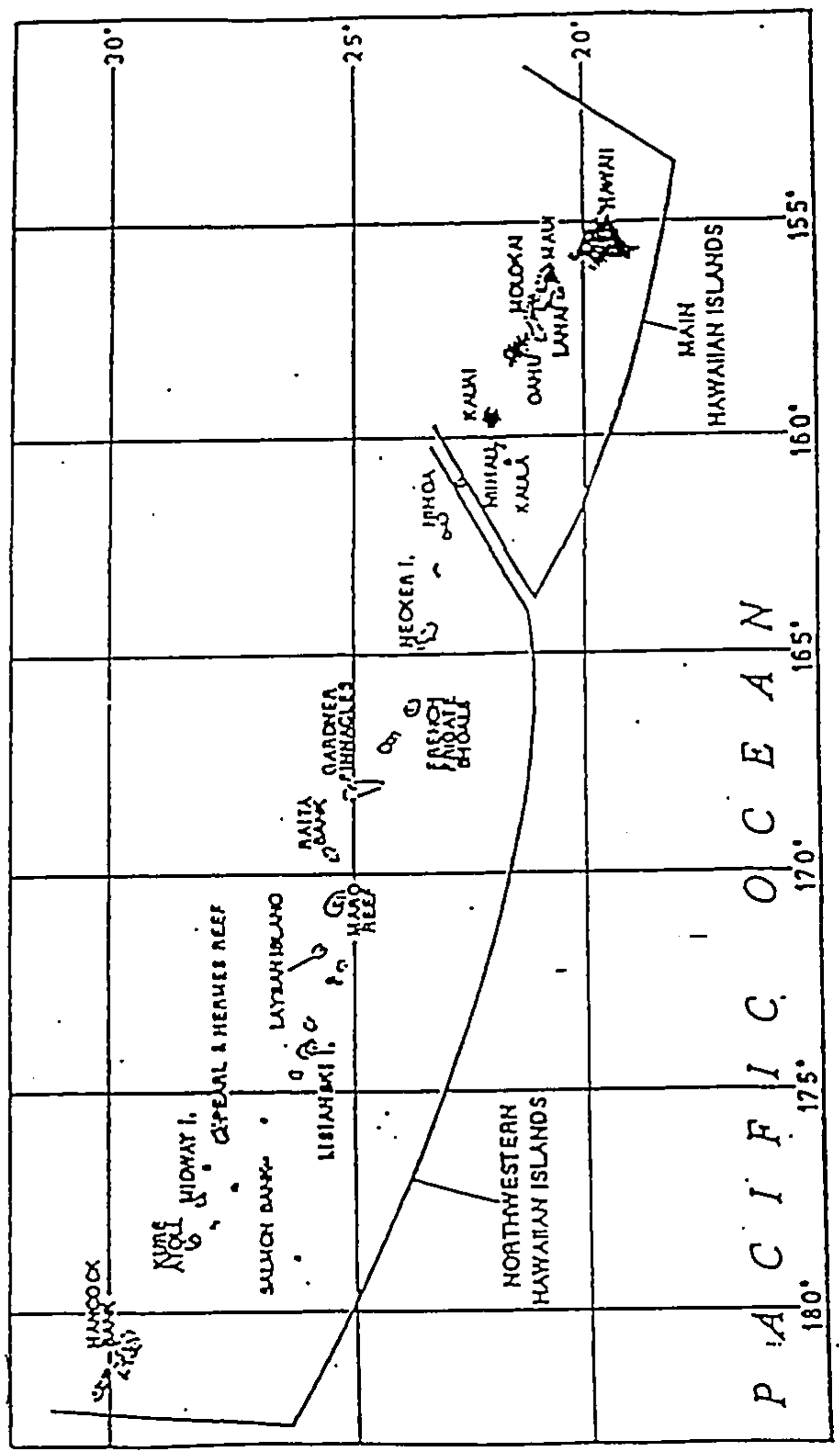


Figure 3.3.1.1-1 Main Hawaiian Islands (MHI) and Northwestern Hawaiian Islands (NWHI)

potentially due to increasing vessel and other human activities. Estimates of the number of individuals in the eastern Pacific stock that enter the Hawaiian chain each year range from 500 to 1000 (Baker, 1985; Baker and Herman, 1987). Recent counts made during simultaneous surveys of the entire chain yielded a direct record of 623 whales in February 1991, and an estimated total of 1584 individuals (Forestell and Mobley, 1991). Comparisons with 1990 aerial survey data and earlier series of surveys (1977-80) suggest an increase in the number of whales arriving in the Hawaiian Island wintering grounds.

During 1993 aerial surveys totaling 840 km of line transects in the proposed study area, a total of 2 humpback cow/calf pairs were observed (Mobley et al., 1994). Early 1994 aerial surveys (5868 km of line transects) yielded a total of 4 humpback cow/calf pairs. Shore station visual observations during January-April, 1994, at two sites on Kauai's north shore over a 100 hr timeframe covering 10 days, noted 21 cow/calf pairs (Smultea et al., 1994). The aerial and shore observations of cow/calf pairs are not additive, as in some cases observations were made simultaneously on the same individuals.

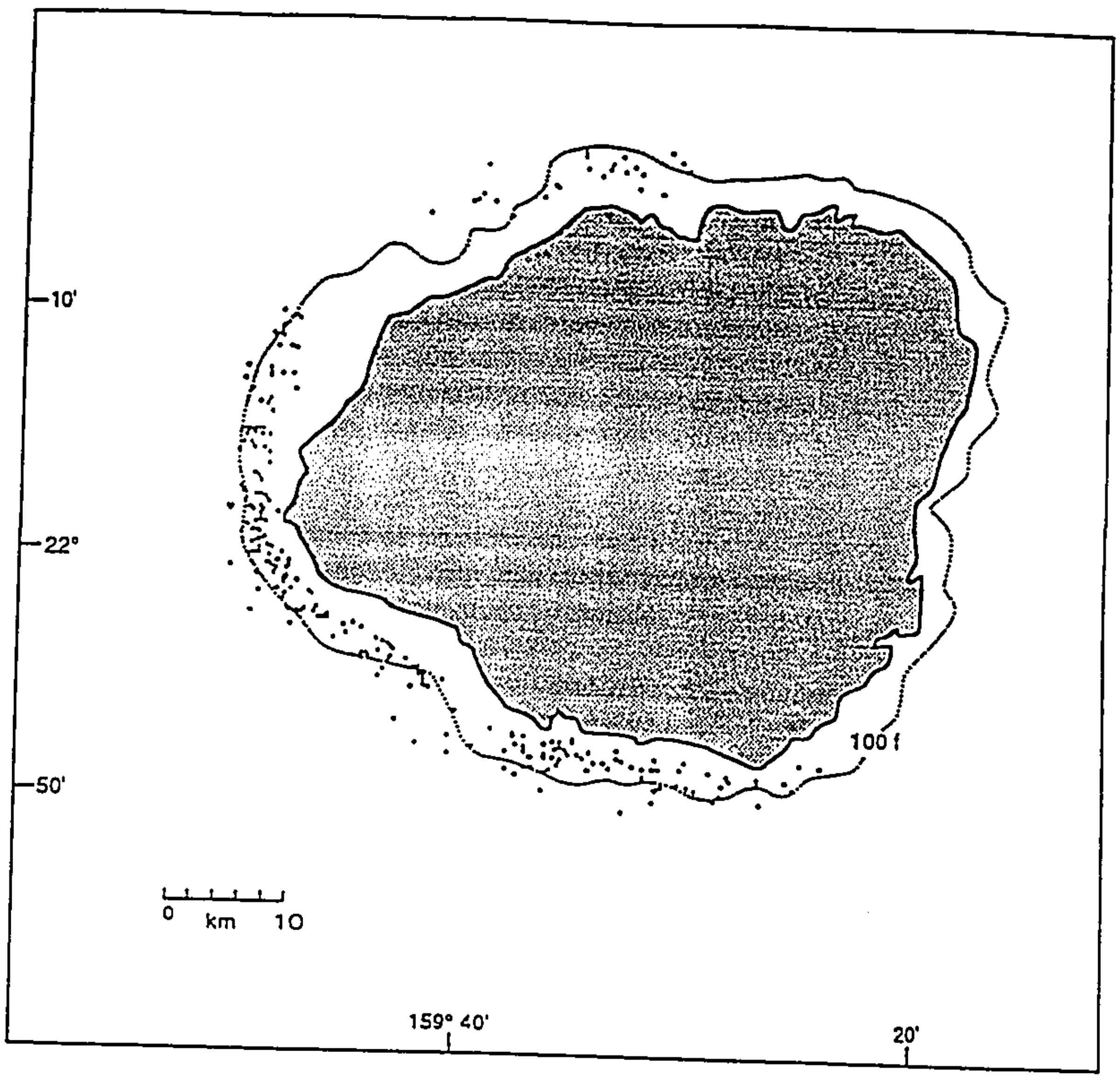
It is not known how many humpback whales of the eastern North Pacific stock transit through the waters off the north coast of Kauai, although it is clear that some age/sex segregation occurs, because cow-calf pairs are sighted less often there than in the calving grounds around Penguin Banks, Kahoolawe, Lanai, and Maui (Cerchio et al., 1991; Mobley et al., 1991; Mobley unpubl. data, 1993). At least 382 individuals were photographed off Kauai (entire coast) during 1990 and 1991 (Cerchio, 1992).

During a one month aerial survey effort in February-March, 1993, 62 humpbacks (including 2 cow/calf pairs) were seen over an 840 km course off Kauai's north shore, equating to approximately one humpback for every 14 km surveyed (Mobley et al., 1993). During four months of aerial surveys between January and May, 1994, 226 humpbacks were observed over 5868 km, representing about one humpback for every 26 km flown.

Humpback whales have, on rare occasions, been observed off Johnston Island (Ludwig, 1982; Corps of Engineers, 1983). However, Johnston Island is not known to support breeding or feeding of this species; thus, the potential for visits to the atoll by humpbacks is low.

Figures 3.3.1.1-2, -3, and -4 depict the densities of humpback whales and their locations during three MMRP data collection evolutions, two during 1993 and one during 1994. More details on these research efforts are available in Appendix G of this EIS.

Fin whales, while uncommon in tropical waters, may occur within 200 nm (370 km) of Hawaii during winter months, when they disperse throughout the lowest latitudes of their distribution (Balcomb, 1987). A single fin whale sighting occurred approximately 37 km north of Kauai in 1994 (Mobley and Grotefendt, 1994). Fin whales commonly travel in herds ranging from between 6-12 individuals, to nearly 100 or more (Balcomb, 1987). Diving depths for fin whales may potentially reach 335 m, remaining submerged for nearly 20 min (Scholander, 1940). They feed on small fish, crustaceans and squid (Caldwell and Caldwell, 1983). No fin whales have been observed near Johnston Atoll.



(from Cerchio, 1994)

Figure 3.3.1.1-2 Kauai 1993 MMRP photo-ID locations of humpback whales (1/30/93 -4/21/93)

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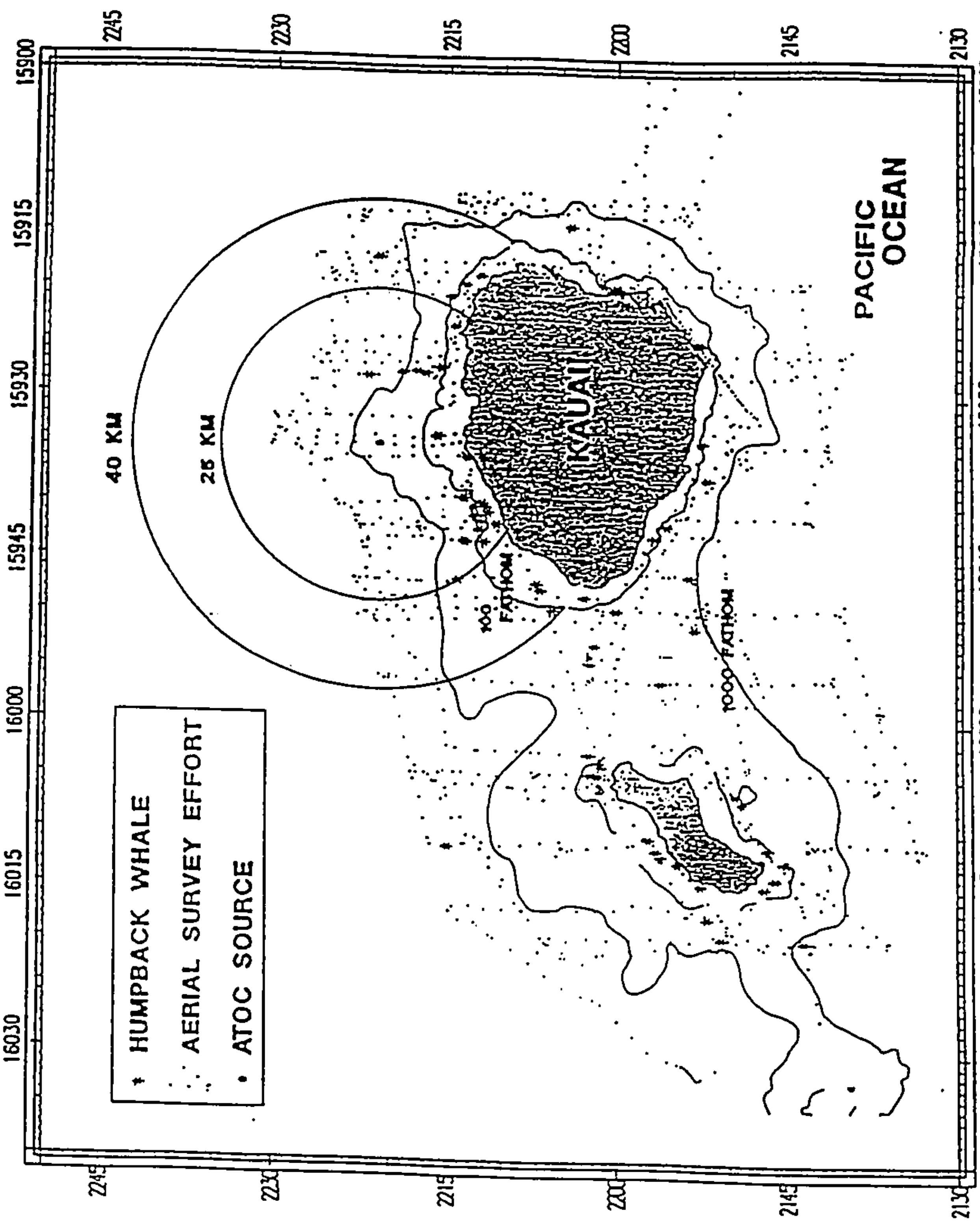

Figure 3.3.1.1-3 Kauai 1993 MMRP aerial survey locations of humpback whales (2/1/93-3/26/93)

(from Mobley et al. 1994)

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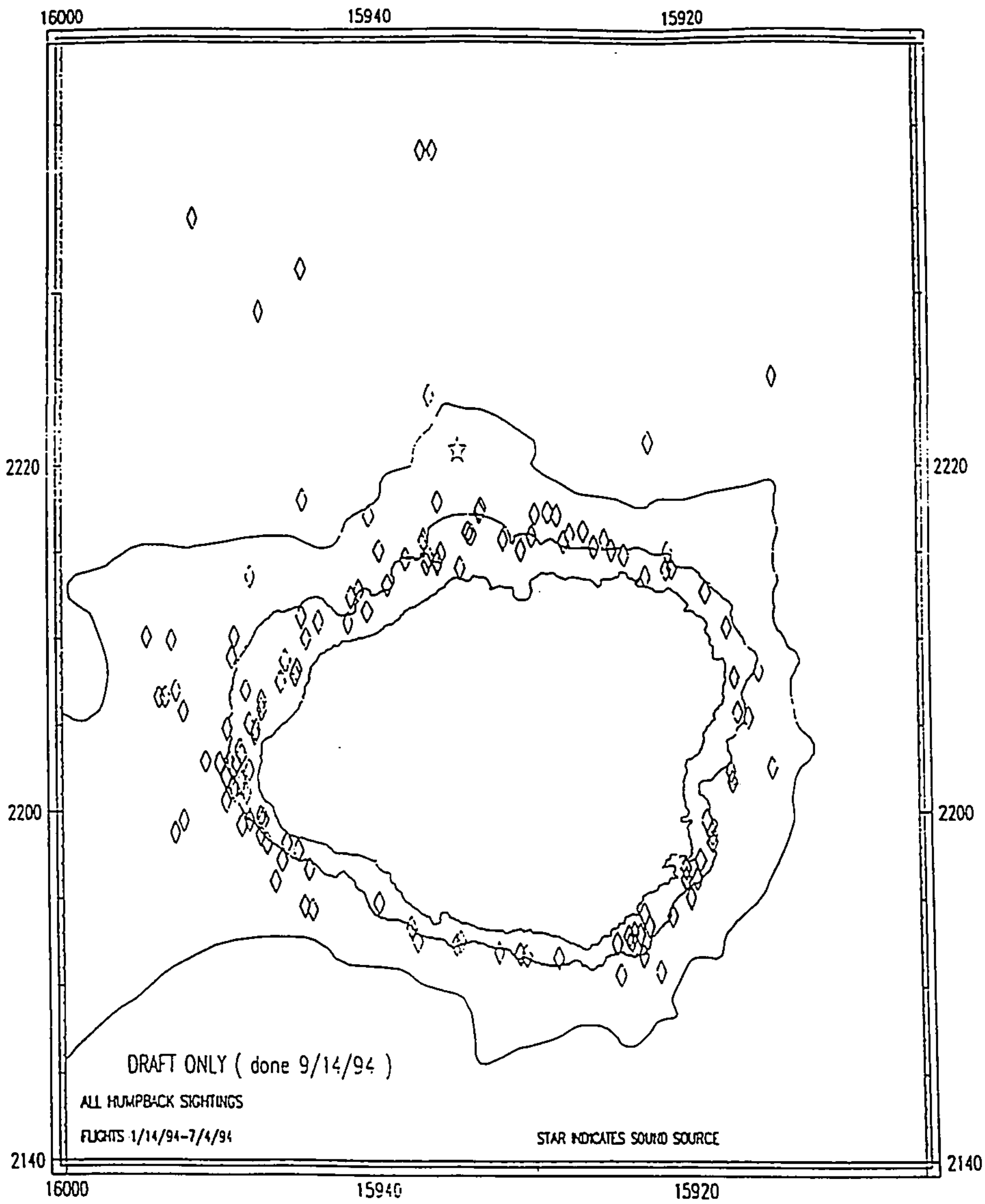


(from Mobley et al. 1994)

Figure 3.3.1.1-4 Kauai 1994 MMRP aerial survey locations of humpback whales (1/14/94-7/4/94)

Blue whales have never been observed in the Hawaiian archipelago; however, their range could overlap the study area. Blue whales are not known to make prolonged deep dives, but may possibly dive to depths of approximately 200 m, remaining submerged for up to 18 min (Mate et al., 1992). Blue whales grow to lengths of more than 30 m, feeding primarily on plankton such as krill (Caldwell and Caldwell, 1983). The range of blue whales also overlaps the Johnston Atoll region; however, none have been reported near this site.

Right whales can be found in nearshore habitats and bays from the Bering Sea to central Baja California. A single right whale was observed in 1979 near Maui (Herman et al., 1980). Right whales are typically observed in temperate and subpolar waters. This species is not known for making deep dives, with maximum diving depths believed to be less than 200 m (Castro and Huber, 1992). It is highly unlikely that this species occurs within the Kauai study area. No right whales have ever been reported in the vicinity of Johnston Atoll.

3.3.1.2 Odontocetes

Sixteen species of toothed whales and dolphins may be found in the Kauai study area. Table 3.3.1-1 lists some of the most abundant odontocete species expected off the north coast of Kauai, with their estimated stock values, and explanatory notes on the methodology and references from which the values were derived.

The following species of odontocetes were sighted in or near the proposed study area during surveys conducted in 1993 by the University of Hawaii under NMFS permit No. 810: sperm whales (*Physeter macrocephalus*), short-finned pilot whales (*Globicephala macrorhynchus*), beaked whales (*Ziphius cavirostris, Berardius bairdi, and Mesoplodon* spp.), spinner and spotted dolphins (*Stenella* spp.), bottlenose dolphins (*Tursiops truncatus*), and rough-toothed dolphins (*Steno bredanensis*).

Other species believed to inhabit the study area include pygmy sperm whales (*Kogia breviceps*), dwarf sperm whales (*Kogia simus*), striped dolphins (*Stenella coeruleoalba*), killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), pygmy killer whales (*Feresa attenuata*), and melon-headed whales (*Peponocephala electra*). Based on the limited density data available, it is believed that the population abundances of these species in the eastern tropical Pacific, including Hawaiian Island coastal waters, are quite small.

Sperm whales, although listed as endangered, are considered to be the most abundant of the large whale species, numbering an estimated 1,900,000 animals worldwide (Rice, 1989). Berzin (1971) reported that they are restricted to waters deeper than 300 m, while Watkins (1977), and Whitehead and Weilgart (pers. comm., 1993) reported that they are usually not found in waters less than 1000 m deep. When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke, 1956). They can dive to depths of at least 2000 m, and may remain submerged for an hour or more (Watkins, 1993).

Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark et al., 1993), but may also eat a variety of fish (Caldwell and Caldwell, 1983).

Stock definition (i.e., identification of separate stocks) and stock structure (i.e., sex and age composition associated with future reproductive success) are not well understood in sperm whales, although well established populations occur in each major ocean basin. There also is uncertainty about the methods and models used to estimate historical and present abundances (e.g., IWC, 1988). As such, a full assessment of the status of the individual stocks is not possible at this time. Table 3.3.1-1 lists the best estimate of sperm whale stock in the Kauai area.

During summer, sperm whales migrate to higher latitudes, with mature males migrating much farther north than females and younger males. In the Pacific Ocean, females and younger whales usually remain in tropical and temperate waters (between 40°N and 45°S Latitude [Rice, 1978]), while males continue north to the Gulf of Alaska, Aleutian Islands, and the Bering Sea, or south to the Antarctic. Females and younger animals may be restricted in their migrations by an intolerance to low water temperatures. Breeding herds are confined almost exclusively to warmer waters, and many of the larger males return to lower latitudes in the winter to breed. Sperm whales in the Pacific Ocean during this time are usually distributed below 40°N Latitude. Historically, sperm whaling grounds in the Pacific south of 40°N Latitude were located around the Hawaiian Islands, among other areas. No sperm whales have been reported near Johnston Atoll.

False killer whales and pygmy killer whales are found infrequently in Hawaiian waters during all seasons (Balcomb, 1987). Both species travel in groups of half a dozen to over several hundred individuals. Prey for these species include many species taken by humans, such as dolphin fish or mahi mahi (*Coryphaena hippurus*) and squid. Based on recent information from the Vancouver Aquarium, killer whales commonly dive as deep as 100 m and may, on occasion, dive as deep as 500 m (Ford, pers. comm., 1995). False killer and pygmy killer whales likely are able to dive as deep as killer whales, but probably no deeper Over 200 individuals were reported off the Kauai study area during recent MMRP surveys (Table 3.3.1-1). No false killer whales or pygmy killer whales have been reported near Johnston Atoll.

Pilot whales are among the most ubiquitous and numerous of all cetaceans, occurring worldwide in all but polar seas (Balcomb, 1987). Off the Hawaiian Islands, the most abundant pilot whale species is the short-finned pilot whale. This species occurs year-round in Hawaiian waters in herds of 20-40 individuals, with aggregations of over 100 occasionally observed. Radiometric studies have shown that these whales can dive to depths of at least 610 m (Leatherwood and Reeves, 1983), feeding on squid and fish (Caldwell and Caldwell, 1983). A total of 67 short-finned pilot whales were reported in the Kauai study area during recent aerial surveys (Mobley et al., 1994). No pilot whales have been reported off Johnston Atoll.

Three species of beaked whales, including Baird's, Blainville's, and Cuvier's beaked whale occur in Hawaiian waters (Balcomb, 1987). Overall, there is much uncertainty about the number and seasonal distribution of beaked whales. While it is extremely unlikely to find Baird's beaked whales around the main Hawaiian Islands, this species has been observed within a few hundred kilometers north of the archipelago. Blainville's beaked whales also have been observed in Hawaiian waters, but are considered rare in occurrence. In recent years, a few individuals were identified and photographed in Hawaii. The most widely distributed of all beaked whales, Cuvier's beaked whale, occur year-round in deep offshore Hawaiian waters. Similar to the other beaked whales off Hawaii, Cuvier's beaked whales have only been observed and photographed on rare occasions. Most beaked whales are thought to forage offshore in relatively deep water (Leatherwood et al., 1987; Mead, 1989), diving as deep as 1000 m (Matsuura, 1943; Pike, 1953; Tomilin, 1957; Balcomb, 1987), feeding on various fish and squid (Balcomb, 1987). A total of 5 beaked whales were observed during recent aerial surveys in the Kauai study area (Mobley et al., 1994). Two Cuvier's beaked whales have been reported off Johnston Atoll, one in 1989 and one in 1990 (Nitta, pers. comm., 1995).

Bottlenose dolphin are probably the best known of all cetaceans due to their inherent presence around vessels and their high survival rate and adaptability in captivity (Balcomb, 1987). Around Hawaii, there are numerous populations of this species occupying harbors and coastlines. Bottlenose dolphins feed on a wide variety of fish, squid, shrimp, and crab (Caldwell and Caldwell, 1983). They can dive to maximum depths of up to 535 m, remaining submerged for up to 8 min (Kanwisher and Ridgway, 1986).

Spinner dolphin (*Stenella longirostris*) are found in tropical oceans throughout the world (Balcomb, 1987). In Hawaiian waters, they gather in large herds at night, offshore and in deep channels between the islands, for feeding. They disperse during the day into smaller groups and move into nearshore resting habitats (Balcomb, 1987). A total of 525 spinner dolphin were reported during recent aerial surveys in the Kauai study area (Mobley et al., 1994). Feeding habits and diving depths of this species are largely unknown, but it is unlikely they dive deeper than bottlenose dolphin (535 m).

Rough-toothed dolphin are relatively common in the vicinity of the Hawaiian Islands in offshore waters, typically occurring over bottom depths greater than 500 m (Balcomb, 1987). This species usually travels in groups of 3-4 individuals with sometimes many small groups utilizing one area. Rough-toothed dolphin feed primarily on pelagic invertebrates, such as squid and octopus (Caldwell and Caldwell, 1983). Only 35 rough-toothed dolphin were reported in the Kauai study area during recent aerial surveys (Mobley et al., 1994). This species is probably capable of diving to relatively moderate depths (e.g., 300 m), based on the type of prey consumed (Balcomb, 1987).

Several species of spotted dolphin inhabit tropical oceans and seas worldwide (Balcomb, 1987). In the vicinity of the Hawaiian Islands, the most common species of spotted dolphin is *Stenella attenuata*. These dolphins travel in large herds, sometimes exceeding 1000 individuals. They feed primarily in offshore waters on squid and fish (Balcomb, 1987; Caldwell and Caldwell, 1983), and probably are able to dive to moderate depths (e.g., 300 m).

Although little site-specific information exists on most of the above dolphin species in the vicinity of Johnston Atoll, it is likely that some of these species are present in offshore waters near the atoll. In fact, the Hawaiian Marine Mammal Stranding Network indicates there are at least two records of stranded beaked whales (Cuvier's) on Johnston Island, one in March, 1989 and one in November, 1990 (Nitta, pers. comm., 1995).

3.3.1.3 Pinnipeds

The Hawaiian monk seal or ilio-holo-i-ka-uaua (*Monachus schauinslandi*) occurs only in the Hawaiian Islands, where its greatest distribution is in the small, mostly uninhabited chain of islands and atolls stretching 1100 nm (2037 km) northwest of the main Hawaiian Islands, most of which are included in the Hawaiian National Wildlife Refuge (Tomich, 1986; USFWS, 1984). This is the only pinniped species known to occur within the general study region. Monk seals are reported from around the main Hawaiian Islands (USFWS, 1984). They tend to stay near land (Tomich, 1986), and small numbers (1-4) are regularly seen around Kauai and each of the other main Hawaiian Islands (Nitta, pers. comm., 1995). There is a small undetermined population on Niihau. Most pups are born between March and May, but pupping has been recorded year-round (U.S. Dept. of Commerce, 1986). A single female gave birth to a female pup on the north coast of Kauai in 1988 (Reeves et al., 1992) and a pup was born in the Poipu Beach area during the summer of 1989 (Naughton, pers. comm., 1990a). There were three monk seal sightings on Kauai in 1993 (Anahola, Kipu Kai, and Kapaa). One monk seal was observed off the north shore of Kauai during recent shore-based MMRP surveys (Smultea et al., 1994). Virtually nothing is known about the distribution and movement patterns of this species when they are at sea (Gilmartin, 1983; U.S. Dept. of Commerce, 1986).

Counts of Hawaiian monk seals have been made since the late 1950s at the atolls, islands, and reefs where they haul out on the northwest Hawaiian Islands (NMFS, 1991). In 1982, the highest count for all atolls was about 50% of those made in 1957-58. NMFS (1991) estimates that currently the monk seal population is slightly more than 1000 animals. By most recent counts, it appears that the population is declining at about 5%/yr (Ragen, pers. comm., 1995). However, based on data collected at the five major haul-outs, the number of births recorded in 1990 declined by 23% from the average annual levels recorded between 1983 and 1989 (NMFS, 1991).

At the breeding islands, monk seals feed on octopus, spiny lobster, eels, bottom fish, and reef fish (Rice, 1960; Gilmartin, 1983). Limited data on diving patterns indicate that for adult males about half of their foraging activity is shallower than 35 m (NMFS, 1991); however, recent time-depth recorder information from a tagged monk seal revealed that it dove to at least 500 m (Ragen, pers. comm., 1995).

The first Hawaiian monk seals recorded outside of the Hawaiian Islands appeared on Johnston Atoll in 1968 and 1969. The first record was a pup observed in March, 1968 that remained on the atoll until late December. During this time it was reported on nearly every part of the atoll but returned to sleep near the Navy docks on Johnston Island (Schreiber and Kridler, 1969). In January, 1969, an untagged adult female hauled out on a protected beach on Sand Island and gave birth to a female pup. The two animals were tagged and remained near the beach until early March, when the adult disappeared. The pup remained until 1971, when it died from a deep flesh wound, presumably from a shark attack.

Although Hawaiian monk seals breed primarily at Laysan Island, Lisianski Island, and Pearl and Hermes Reefs (Tomich, 1986), they are also known to use the Midway Islands, among other northwest Hawaiian Islands (USFWS, 1984).

3.3.2 SEA TURTLES

Leatherback and hawksbill sea turtles are federally listed as endangered, while green and olive ridley sea turtles are federally listed as threatened species and, thereby, protected by the ESA (1973).

Five species of sea turtle occur in the Pacific Ocean near the Hawaiian Islands: the green turtle or honu (*Chelonia mydas*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), hawksbill or èa (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*). Hawksbills and leatherbacks are listed at the federal and state levels as endangered (DLNR, 1993). Olive ridley and green turtles are listed as threatened at the federal and state levels (DLNR, 1993), with the exception of Mexican breeding populations that are considered endangered. Balazs et al. (1992) suggested that olive ridleys occurring in Hawaiian waters are likely derived from the Mexican breeding populations, and therefore should be considered endangered. Loggerheads are rare in Hawaiian nearshore waters, with only four documented occurrences: two juveniles from the southeastern part of the archipelago, one juvenile removed from the stomach of a tiger shark captured near Kure Atoll, and one adult female sighted near Oahu (Eckert, 1993). This species is not on the State of Hawaii list of threatened and endangered species and therefore, detailed information is not presented.

The distribution of each species has been determined from one or more of the following: 1) observations of adult females emerging to nest on beaches and/or adult males basking on beaches or other substrates; 2) observations of turtle tracks, hatchlings, or egg shells on beaches; 3) reports of incidental capture by commercial fisheries; 4) incidental observations by fishermen or other mariners; 5) mark-recapture studies of adult females; and 6) radio (VHF) and satellite (UHF) telemetry studies of adult males and females. All four species have worldwide extensive ranges. However, genetic analysis of sea turtles has revealed in recent years (i.e., many published accounts) that discrete non-inter-breeding stocks of sea turtles make up these "worldwide extensive ranges" of the various species. It is generally believed that all sea turtle species spend the first few years of their life in pelagic waters, occurring in driftlines and convergence zones, where they find refuge and food in the items that accumulate in surface circulation features (Carr, 1986, 1987). The most accurate abundance estimates in the study region are for adult female green turtles and hawksbills that nest annually on Hawaiian beaches. Leatherbacks and olive ridleys do not nest regularly, or in great numbers, in the Hawaiian Islands, and loggerheads do not nest in the Hawaiian Islands at all.

The green turtle is considered the most abundant sea turtle in Hawaiian waters. Its population consists of an estimated 1400 adult females (Balazs et al., 1993). Green turtles tagged in the Hawaiian Archipelago rarely are recaptured or observed elsewhere. Notable exceptions are Johnston Atoll, over 800 km to the southwest (NMFS, 1992); and two recoveries in the western Pacific (one in Japan and one in the northern Philippines) (Balazs, 1983). The lack of recaptures, in addition to research concluding Hawaiian green turtles are genetically distinct (Bowen et al., 1992), suggests that these turtles are essentially restricted (or geographically limited) to this area of the Pacific Ocean.

Green turtles primarily occur in coastal waters, where they forage on algae and seagrass (Balazs, 1980; NMFS/SWFSC, 1993), suggesting they are limited to the photic zone (i.e., upper water column, from the oceanic surface to 150-300 m) surrounding islands and continents. Because this species feeds in the photic zone and prefers warmer water temperatures, they are not expected to dive regularly to depths greater than 200-300 m (beyond the photic zone). During the breeding season, adult green turtles undertake long distance, oceanic migrations from feeding areas located throughout the Hawaiian Archipelago and Johnston Atoll, to nesting beaches at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl Reef and Hermes Reef, Kure Atoll, and Midway Island (Balazs, 1980; Balazs et al., 1992; Balazs, 1993). Four postnesting female green turtles were fitted with satellite transmitters to monitor their migrations from French Frigate Shoals (Balazs, 1994). All four turtles migrated to Oahu, with three of them traveling south of Kauai, over open ocean. The fourth migrated along the chain of islands, swam toward the southern edge of Kauai, traveled north along the east coast, and then veered off towards Oahu (Balazs, 1994). These are the only green sea turtles that have been tracked and none of them were "Kauai" turtles (i.e., turtles that returned to resident foraging pastures on the island of Kauai). The nearshore waters of Kauai, especially the north shore area, are important habitats for post-pelagic subadult and adult green turtles (Balazs, 1980, 1983). It would be worthwhile to know what migratory pathways are followed by adult turtles moving between Kauai and French Frigate Shoals. Some answers are expected when transmitters are deployed on 2-3 turtles during the breeding season at French Frigate Shoals during the June-August 1995 timeframe (Balazs, pers. comm., 1995).

Green turtle breeding may occur along oceanic migration routes, but appears to be most concentrated at nearshore nesting beaches from mid-April through early June (Balazs, 1980; Balazs et al., 1992). Approximately 90% of green turtle nesting in the Hawaiian Islands occurs at French Frigate Shoals, with an estimated 100-250 animals laying eggs along the shore annually between May and September. Average age at first reproduction in the Hawaiian Islands has been estimated to be 25 yrs (Balazs et al., 1992). From July through October, the hatchlings emerge from nests and swim offshore, where they tend to accumulate in surface driftlines. Juvenile and sub-adult green turtles (35-82 cm carapace length) are abundant nearshore Hawaii, Maui, Kahoolawe, Molokai, Oahu, Kauai, and Niihau Islands (NMFS/SWFSC, 1993). Adults are benthic herbivores, suggesting that they are restricted to photic zones (i.e., upper oceanic surface layer through which light may penetrate, corresponding to water depths ranging from the surface to approximately 150 m) surrounding islands and continents. Because green turtles feed in the photic zone and prefer warm water temperatures above 15°C (Eckert, pers. comm., 1994), they are not expected to dive regularly to depths greater than 200 m (beyond the photic zone). This species is reported as a relatively regular visitor to Johnston Atoll, being observed in the shallow lagoon areas, as well as in offshore habitats (Amerson and Shelton, 1976).

Juvenile, sub-adult, and adult hawksbills occur in Hawaiian waters, but are uncommon. Hawksbills generally are associated with coral reefs or other hard substrate areas, where they forage primarily on sponges (Meylan, 1988). An estimated 12 hawksbills nest on Hawaii and Molokai each year from July through November (Balazs et al., 1992). Hawksbill migration routes are unknown. No hawksbill turtles have been reported in the vicinity of Johnston Atoll.

Adult leatherbacks are commonly sighted in the Pacific Ocean near the Hawaiian Archipelago, primarily over deep, oceanic waters (Thoulag, 1993; Wetherall, 1993), where they forage on jellyfish and other gelatinous pelagic invertebrates (Leary, 1957; Mortimer, 1981; den Hartog and Van Nierop, 1984) at depths that sometimes correspond with the deep scattering layer (Eckert et al., 1989). This species has been recorded to dive (two occasions) to depths exceeding 1000 m. However, Eckert et al. (1986) reported that the average diving depth and duration of dives for leatherbacks were approximately 62 m and 10 min/dive, respectively. Leatherbacks undertake extensive migrations (Pritchard, 1976), following depth contours (Morreale et al., 1993) for hundreds, or even thousands, of kilometers. Females may nest at several beaches, spatially separated by hundreds of kilometers, within a nesting season. Migratory and reproductive information on leatherbacks, in addition to preliminary results from genetic studies (Dutton, pers. comm. 1993), suggests that they are wide-ranging and not restricted to any one region. There has been an alarming decline in the number of nesting females in Maylasia (1950: 1800 females; 1987: 100 females)(Marquez, 1990). Leatherbacks do not nest regularly in the Hawaiian Islands, although there is one report of an unsuccessful nesting attempt on Maui, and one unconfirmed nesting on Kauai (Eckert, 1993). No leatherback turtles have been reported in the vicinity of Johnston Atoll.

Olive ridleys are not common in Hawaiian waters, although they are the most abundant sea turtle in the eastern Pacific Ocean (Pitman, 1990). They are nomadic migrants that swim hundreds to thousands of kilometers during migrations (Marquez, 1990), foraging on salps, tunicates, pelagic crustaceans, and other invertebrates (Fritts, 1981; Mortimer, 1981). Olive ridleys spend a large portion of their time at the surface (Byles and Plotkin, 1993; Pitman, 1993), but have been reported to dive to depths of nearly 300 m in the Sea of Cortez (Eckert, pers. comm., 1994). Post-nesting females can travel over 9000 km in 16 months. The reproductive cycle is nearly annual with greater than 60% of the females nesting every year (Eckert, 1993). However, very little is known about the behavior and movements of males (Eckert, 1993).

Most records of this species in Hawaiian waters are of sub-adults stranded after becoming entangled in ocean debris or discarded fishing gear (Balazs, 1985), or captured incidentally by pelagic longline fisheries. There is only one report of a successful nesting in the Hawaiian Islands region, on Maui (Balazs and Hau, 1986). No olive ridleys have been reported in the vicinity of Johnston Atoll.

Table 3.3.1-1 provides estimates for the potential stocks of these five sea turtle species in the area off the north coast of Kauai.

3.3.3 FISH

Hawaiian waters are comprised of a broad range of onshore to offshore habitats, from sandy beaches and rocky tidepools, to coral reefs and submerged basaltic terraces and banks, to pelagic and soft substrate ecosystems. Diverse coral reef and nearshore reef fish, deepwater demersal (bottomfish), and migratory pelagic fish (those that spend part or all of their lives in the water column) are characteristic of these habitats. Epipelagic (surface to approximately 200 m depth), mesopelagic (between 200 and 1000 m), and bathypelagic (>1000 m depth) zones also support a wide variety of fish species, including some which are important components of the Hawaiian Islands commercial and sport fisheries. Section 3.3.3.1 discusses some of the common demersal (bottom-dwelling) species on nearshore and offshore areas in the vicinity of Kauai and Johnston Atoll. Common epipelagic, mesopelagic, and bathypelagic species are discussed in Section 3.3.3.2.

3.3.3.1 Demersal Species

Demersal fish are defined as those species living on or near the sea floor. Nearshore habitats and reef fish from approximately 0 to 50 m depth off the north shore of Kauai were described in 1980, as part of the EIS for the Princeville community development (Grigg and Dollar, 1980). Surveys were conducted from Haena Point to Kilauea Lighthouse (Figure 1.1.5-3). Similar to other islands within the Hawaiian Archipelago, rough basaltic substrates off north Kauai support a diverse tropical reef fish fauna (Grigg, 1993). Common nearshore demersal fish families observed off north Kauai include squirrelfish (Holocentridae), snappers (Lutjanidae) such as Onaga, Ehu, Opakapaka, and Ta'ape, goatfish (Mullidae) such as Weke, Weke-ula, Kumu, Maono, and Moano Kea, and sea chubs (Kyphosidae) (Grigg and Dollar, 1980). The primary diet for most of these species include crustaceans and other benthic invertebrates associated with rock and coral rubble bottoms (Hobson, 1974).

During fish spawning seasons, the northeastern to southern coasts of Kauai support abundant and diverse nearshore reef fisheries (Smith, 1993). The most common fish species include bigeye scad or Akule/Hahalalu, mackerel scad or Opelu, goatfish such as white/green Weke, and squirrelfish or U'u. Although abundance and biomass data are not available for these species, the nearshore reef study area community probably has relatively high fish densities. Additional fish families that contribute to the relatively high diversity include damselfish (Pomacentridae), wrasses (Labridae), parrotfish (Scaridae), surgeonfish (Acanthuridae), and mackerel jacks (Carangidae) (Grigg and Dollar, 1980).

Deepwater demersal fish assemblages between 50 and approximately 400 m depths on offshore banks and the deep-reef slopes off Kauai are dominated by snappers and grouper (Serranidae) such as Hapu'upu'u. Densities in these areas are probably relatively high, and deepwater snapper in Hawaii have been commercially exploited since the early part of the century (Haight et al., 1993). Similar to other shelf and slope communities throughout the Pacific ocean, fish densities and biomass decrease as depth increases. Rattails (Macrouridae) and cod (Moridae) are dominant residents of the deepwater complex (including the bathypelagic zone), and comprise the highest biomass in this area. These species feed on a variety of prey, including krill, shrimp, crabs, and small fish (Love, 1991).

The deep-sea benthic fish of the Hawaiian Archipelago, including Johnston Atoll are described by Chave and Mundy (1994). More than 250 benthic fish species were photographed and videotaped by Hawaii Undersea Research Laboratory (HURL) submersibles at depths ranging between 40 and 2000 m. Most of the species observed occurred close to hard substrates, holes, ledges, or caves. Large schools of fish were observed over sand-bottom habitats in troughs when the bottom currents were strong. Chave and Mundy (1994) found 51 species restricted to Johnston Atoll, with a rapid decrease in diversity from 200 to 400 m. The deepest species observed were rattails, halosaurids, and congrids (conger eels).

3.3.3.2 Pelagic Species

The surface waters of the ocean to depths of nearly 200 m (epipelagic zone) represent an enormous, although relatively featureless, habitat for fish (Moyle and Cech, 1988). Epipelagic waters are typically well-lighted, well-mixed, and capable of supporting actively photosynthesizing algae. At depths between 200 and approximately 1000 m (mesopelagic zone), light decreases rapidly, as does temperature and dissolved oxygen concentrations, while pressure increases. At depths greater than 1000 m (bathypelagic zone), conditions are characterized by complete darkness, low temperatures, low oxygen concentrations, and great pressure. Each of these zones is distinguished by characteristic fish assemblages.

Epipelagic fish can be distinguished based on two ecological types. Ocean forms are those that spend all or part of their life in the open ocean, while neritic forms spend all or part of their life in shallower waters of the island shelf and island offshore areas (Moyle and Cech, 1988).

Hawaii's pelagic fisheries are relatively small in comparison with other Pacific pelagic fisheries (NMFS, 1991), but comprise a large proportion of the commercial and recreational catch in the state (Pooley, 1993). Off Kauai, higher total landings, including yellowfin tuna or Ahi, are taken on the leeward (southwestern) side of the island (Smith, 1993). Other common epipelagic fish species found off Kauai include jack fish (primarily *Caranx* spp.), bigeye scad, and mackerel scad.

The larger migratory pelagic fish that comprise a substantial part of Hawaii's commercial, recreational, and sport and game fish fisheries include Ahi, albacore (*Thunnus alalunga*), skipjack tuna or Aku (*Katsuwonus pelamis*), blue marlin or A'u (*Makaira nigricans*), striped marlin or A'u (*Tetrapturus audax*), broadbill swordfish or Shutome (*Xiphias gladius*), dolphinfish or mahi mahi (*Coryphaena hippusus* and *C. equiselis*), wahoo or Ono (*Acanthocybium solandri*), shortbill spearfish (*Tetrapturus angustirostris*), sailfish (*Istiophorus platypterus*), and black marlin (*Makaira indica*). Abundance data are not available for most of these species. However, additional information on their contribution to Hawaii's fisheries is discussed in Section 3.4.1.

Most mesopelagic fish species undergo vertical migrations, often moving into the epipelagic zone at night to prey on plankton and other fish (Moyle and Cech. 1988). Mesopelagic species found in Hawaiian waters are similar to those found in other areas of the Pacific. For example, lanternfish (Myctophidae), a common mesopelagic fish family, is represented in the Hawaiian waters by a variety of species including the Honolulu lanternfish (*Myctophum hollandi*). Other species likely include bristlemouths (Gonostomatidae) and some deep-sea smelts (Bathylagidae).

In contrast to mesopelagic fish, bathypelagic species are largely adapted for a sedentary existence in a habitat characterized by low levels of food and no light (Moyle and Cech, 1988). Most of the species occupying the bathypelagic zone also cross into the mesopelagic zone during diurnal vertical migrations. At depths greater than 1000 m, bathypelagic species likely to occur in Hawaiian waters include blackdragons (Idiacanthidae), dragonfish (Melanostomiidae), and tubeshoulders (Searsiidae).

In addition to the most common pelagic species described above, several shark species are common inhabitants of the nearshore and offshore waters off Kauai and in the vicinity of Johnston Atoll. Sharks are a diverse group, occupying shallow and deep water habitats worldwide.

Sharks and other species have been an important aspect of Hawaiian culture. For example, the Hawaiian dictionary lists nine Hawaiian Gods that were associated with sharks, with some being revered as influential spirits important to specific geographic areas (Taylor, 1993). Further, it was believed that under certain conditions a deceased relative could be reincarnated in the form of a specific shark known by a special name (Taylor, 1993). For example, a shark could be a guardian spirit or aumakua, or a fishing helper or unihipili.

Some of the most common shark species include pelagic requiem sharks (Carcharhinidae) or mano, thresher sharks (Alopiidae) such as the pelagic thresher mano' ula or laukahi, and mackerel sharks (Lamnidae) such as the great white shark or niuhi (*Carcharodon carcharius*) (NMFS, 1991). Tiger sharks or niuhi (*Galeocerdo cuvier*) occur in the Kauai study area; having an ecologically important role as apex predator in the offshore pelagic and deep reef ecosystems. While great whites occur mainly in continental and island inshore waters where their main prey items occur, they have been taken at depths over 1400 m (Love, 1991). In contrast, tiger sharks consume mainly vertebrates, such as sea turtles (Taylor, 1993), but also select various invertebrates such as lobster and squid.

Pelagic requiem sharks such as various species of gray shark are the most common sharks in the Hawaiian waters. The gray shark most often encountered around Hawaiian reefs is the sandbar shark (*Carcharhinus milberti*) or mano (Hobson and Chave, 1990). These occur in relatively shallow waters and prey on a variety of reef fish (Taylor, 1993). Other species of sharks, including the whitetipped reef shark (*Triaenodon obesus*) and some species of hammerhead sharks, such as the scalloped hammerhead (*Sphyrna lewini*) or manokihikihi and the smooth hammerhead (*S. zygaena*) are abundant near reefs and in deeper offshore areas throughout the Hawaiian archipelago (Hobson and Chave, 1990) and contribute significantly to the offshore longline fishery (Taylor, 1993). Most of these species feed on various fish and invertebrates, occupying relatively shallow nearshore waters (e.g., less than 100 m). Thresher sharks are found near Kauai and Johnston Atoll and are taken commercially in the vicinity of the main Hawaiian Islands, including Kauai. This species ranges in depth from the surface to nearly 150 m (Taylor, 1993).

Specific information on shark species near Johnston Atoll is not available. However, similar species to Hawaii are likely to inhabit nearshore and offshore areas there.

3.3.4 INVERTEBRATES

Site-specific information on the distribution and abundance of infauna (those organisms living within the soft-bottom sediments), demersal epifauna (those organisms living in contact with the sea floor, either on soft- or hard-bottom), and pelagic invertebrates is limited for the study areas. In general, information available on the Hawaiian Islands is expected to be similar for the proposed action and Johnston Atoll sites.

3.3.4.1 Benthic Infauna

Benthic infaunal communities, defined generally as small invertebrates such as polychaetes (marine worms) and amphipods (small crustaceans) living within the sediments, are described by a number of parameters, such as faunal composition (which species are present), dominant taxa (which species are most abundant), density (number of individuals), diversity (number of different species relative to the total number of individuals), species richness (number of species), and community assemblage patterns (which species are usually found together in a sample, or how similar the samples are to each other). No site-specific data are available for the Kauai or Johnston Atoll study areas. However, similar to soft-bottom island shelf and slope habitats throughout the world's oceans, benthic infaunal communities off Kauai are likely dominated by polychaete worms.

Similar to Kauai, little information exists on invertebrate species at Johnston Atoll. However, an earlier study by Amerson and Shelton (1976) indicates that Johnston Atoll may serve as a unique "filter bridge" between the south-central (Polynesian) and western (Micronesian) Pacific fauna and the Hawaiian fauna. Based on collections housed at the National Museum of Natural History, 12 species of polychaetes, belonging to eight families have been collected from lagoons at Johnston Atoll. Predominant families include Cirratulidae, Eunicidae, Polynoidae, Phyllodocidae, Nereidae, Leodicidae, and Leodocidae (Amerson and Shelton, 1976).

3.3.4.2 Demersal Epifauna

The most visible invertebrate fauna on Hawaiian reefs are stony corals, including many reef-forming species (Hobson and Chave, 1990) that are key contributors to nearshore biological structure and diversity off Kauai as elsewhere in Hawaii. Dominant, commercially unexploited coral genera include *Tubastrea, Porites, Montipora* and *Payona*. Coral species have specific

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

the offshore longline fishery (Taylor, 1993). Most of these species feed on various fish and invertebrates, occupying relatively shallow nearshore waters (e.g., less than 100 m). Thresher sharks are found near Kauai and Johnston Atoll and are taken commercially in the vicinity of the main Hawaiian Islands, including Kauai. This species ranges in depth from the surface to nearly 150 m (Taylor, 1993).

Specific information on shark species near Johnston Atoll is not available. However, similar species to Hawaii are likely to inhabit nearshore and offshore areas there.

3.3.4 INVERTEBRATES

Site-specific information on the distribution and abundance of infauna (those organisms living within the soft-bottom sediments), demersal epifauna (those organisms living in contact with the sea floor, either on soft- or hard-bottom), and pelagic invertebrates is limited for the study areas. In general, information available on the Hawaiian Islands is expected to be similar for the proposed action and Johnston Atoll sites.

3.3.4.1 Benthic Infauna

Benthic infaunal communities, defined generally as small invertebrates such as polychaetes (marine worms) and amphipods (small crustaceans) living within the sediments, are described by a number of parameters, such as faunal composition (which species are present), dominant taxa (which species are most abundant), density (number of individuals), diversity (number of different species relative to the total number of individuals), species richness (number of species), and community assemblage patterns (which species are usually found together in a sample, or how similar the samples are to each other). No site-specific data are available for the Kauai or Johnston Atoll study areas. However, similar to soft-bottom island shelf and slope habitats throughout the world's oceans, benthic infaunal communities off Kauai are likely dominated by polychaete worms.

Similar to Kauai, little information exists on invertebrate species at Johnston Atoll. However, an earlier study by Amerson and Shelton (1976) indicates that Johnston Atoll may serve as a unique "filter bridge" between the south-central (Polynesian) and western (Micronesian) Pacific fauna and the Hawaiian fauna. Based on collections housed at the National Museum of Natural History, 12 species of polychaetes, belonging to eight families have been collected from lagoons at Johnston Atoll. Predominant families include Cirratulidae, Eunicidae, Polynoidae, Phyllodocidae, Nereidae, Leodicidae, and Leodocidae (Amerson and Shelton, 1976).

3.3.4.2 Demersal Epifauna

The most visible invertebrate fauna on Hawaiian reefs are stony corals, including many reef-forming species (Hobson and Chave, 1990) that are key contributors to nearshore biological structure and diversity off Kauai as elsewhere in Hawaii. Dominant, commercially unexploited coral genera include *Tubastrea, Porites, Montipora* and *Payona*. Coral species have specific habitat requirements, including a firm (rocky) substratum free of sediment and moderate to strong currents. Most precious coral species are found in deeper waters of the euphotic zone (350 1500 m depth) (Grigg, 1993). Light and temperature appear to influence larvae more than adults.

Precious corals have been collected extensively throughout the Hawaiian Islands and tropical oceans and are used for fabrication of coral jewelry (Grigg, 1989). Historically, the precious coral fishery in Hawaii and the Western Pacific has consisted of one industry but two distinct and separate fisheries (Grigg, 1993). One fishery consists of harvesting black coral by scuba divers at depths between 30 and 100 m. The second is the harvesting of pink and gold corals at depths between 400 and 1500 m by submersibles with tangle net dredges. Currently, there is no pink or gold coral fishery in Hawaii (Grigg, pers. comm., 1994). However, a small fishery still exists for black coral off Maui and the western and southern areas off Kauai. Since their discovery in 1958, black coral (*Antipathes* spp.) have comprised a major part of the commercial coral harvest. For example, total harvest biomass of black coral by Maui Divers of Hawaii, Ltd, ranged from 78 kg in 1982 to 1740 kg in 1991 (Grigg, 1993).

No site-specific information exists for other invertebrate species off Kauai, such as bivalve molluscs and barnacles. However, bivalve species that likely are common in Hawaiian waters (including the Kauai study area) include clams (e.g., *Calyptogena* spp.), pearl oysters (e.g., *Pinctada radiata*), and mussels (e.g., *Mytilus* spp.). Various small gastropod molluscs, such as limpets (particularly the opihi) and cowries, also are prominent members of the invertebrate community on other Hawaiian Islands and likely have similar communities near Kauai and Johnston Atoll, with their known distribution largely in intertidal areas.

Crustaceans, such as crabs and shrimp, also are dominant on or near reefs. Some of the most common Hawaiian reef shrimp include the spiked prawn (*Savon marmaratus*) and banded coral shrimp (*Stenopus hispidus*) (Hobson and Chave, 1990). Deepwater pandalid shrimp are found throughout the tropical and subtropical Pacific (King, 1984; Moffit and Polovina, 1987). Studies in Hawaii have shown that other shrimp species, such as *Heterocarpus laevigatus* and some smaller, more shallow dwelling species, *H. ensifer*, occur at depths ranging between 350 and 825 m (Struhsaker and Aasted, 1974).

A large number of commercially important crustaceans may occur in the general study area (see Section 3.4.1). Spiny lobsters (*Panulirus argus*) and slipper lobsters (*Scyllarides squammosus*) are found primarily in the northwest Hawaiian Islands, including Kauai, and are not considered abundant in the main Hawaiian Islands area. Abundances of these species have dropped substantially since 1989, likely due to overexploitation. Preliminary research suggests that annual variation in current flows along the Hawaiian ridge may also contribute to the variable abundances of these species (NMFS, 1992). Other species taken by handlines and casting nets on nearshore reefs and in embayments include the spinner crab or Kona Crab (*Ranina ranina*) and the white crab or Kuahonu Crab (*Portunus sanguinolentus*). MMS (1987) indicated that no commercial or recreational fishing activities occur off Johnston Atoll.

Some of the most conspicuous animals on Hawaiian reefs include echinoderms, such as sea urchins, sea stars, and sea cucumbers. Three of the most common urchin species, including *Diadema paucispinum*, *Echinothrix calamaris*, and *E. diadema*, are occasionally collected for food (Hobson and Chave, 1990). Other urchin species which are common and abundant on shallow reefs include the pencil urchin (*Heterocentrotus mammillatus*), short-spined urchin (*Echinometra mathaei*), and the black sea urchin or wana (*Diadema paucispinum*).

Sea stars also are prominent members of the Hawaiian reef community. Species likely to occur in the study area include several species of *Linckia*, as well as the crown of thorns (*Acanthaster planci*). During recent decades, the crown of thorns has appeared in exceptionally large numbers at various locations throughout the Pacific Ocean, where it has done extensive damage to local reefs. Thus far, there is no indication that this species is an unusual threat to Hawaiian reefs (Hobson and Chave, 1990).

Sea cucumber species likely to occur within the Kauai and Johnston Atoll study areas include *Holothuria atra*, *Stichopus horrens*, *Euapta godeffroyi*, and *Opheodesma spectabilis* (Hobson and Chave, 1990). These species inhabit a variety of habitats, including rocky reefs, sandy bottoms, and protected bays.

3.3.4.3 Pelagic Invertebrates

Pelagic invertebrates include those species capable of movement throughout the water column and/or just above the bottom. Some of these species migrate over a wide variety of depths, including epipelagic, mesopelagic, and bathypelagic zones. Squid species collected at depths between 200 m and 500 m include representatives from the families Chiroteuthidae, Cranchiidae, Enoploteuthidae and Sepiolidae. The following genera are likely to occur in the water column offshore of Kauai and Johnston Atoll: *Abralia, Chiroteuthis, Heteroteuthis, Histioteuthis, Hyaloteuthis, Liocranchia, Megalocranchia, Onychoteuthis,* and *Pyroteutis* (Reid et al., 1991). Common squid generally are open ocean predatory species.

In addition to the above pelagic invertebrates, a number of pelagic shrimp species are found in the waters off Kauai and Johnston Atoll, some having commercial value. One deepwater species Ono Shrimp (*Heterocarpus laevigatus*) is taken by commercial and recreational fishermen over shelf and slope habitats including southwestern areas off Kauai (Smith, 1993). It is unlikely that Ono are taken off Johnston Atoll (see section 3.5.1).

Many species of pelagic invertebrates are components of the deep scattering layer (DSL). Ingmanson and Wallace (1973) described the DSL as a layer of living organisms, ranging from almost microscopic zooplankton to copepods, shrimp, and squid. This layer is present at different depth ranges during the day (between 300 and 500 m) and night (sometimes near the surface) (Castro and Huber, 1992). Many species occupying the DSL are "vertical migrators" such as zooplankton and certain fish species that utilize this dense layer as a food source.

3.3.5 PLANKTON

Plankton are free-floating organisms that typically drift with ocean currents, in contrast to actively swimming species such as fish. In general, plankton can be divided into three broad categories: 1) phytoplankton, representing single-celled plants that are capable of photosynthesis and which form an important base for many marine systems; 2) zooplankton, which include animals that are a primary link in many food webs between phytoplankton and larger marine organisms such as fish, seabirds, and marine mammals; and ichthyoplankton, which are larval fish. Zooplankton includes animals that remain planktonic throughout their life (holoplankton) as well as larval stages of benthic invertebrates (meroplankton) and fish (ichthyoplankton). Plankton distributions are characterized by high spatial patchiness, strong seasonal and interannual variation, and direct responses to oceanic circulation (McGowan and Miller, 1980). General patterns of coastal circulation are influenced by local topography and wind fields, and can change considerably on time scales of a few days (Breaker and Mooers, 1986), thereby contributing to the high variability in plankton communities.

In coastal and offshore environments, phytoplankton will be limited in distribution from the sea surface to approximately 100 m depth, corresponding to the effective range of light penetration for photosynthesis. In contrast, zooplankton can occur throughout the depth range from surface to bottom.

Site-specific information on the production, abundance, and species composition of plankton communities is not available for the study areas. However, a general description of the plankton communities in the vicinity of the Hawaiian Islands, including Johnston Atoll, is summarized in the following sections and is thought to be representative of the study areas.

3.3.5.1 Phytoplankton

The predominant members of the phytoplankton community are diatoms, silicoflagellates, coccolithophores, and dinoflagellates. Three parameters commonly used to describe phytoplankton communities are: 1) productivity, reflecting the amount of new plant material formed per unit of time; 2) standing crop, representing the amount of plant material present, usually expressed as concentrations of chlorophyll or cell numbers; and 3) species composition.

The most frequently used method for estimating the standing crop (e.g., total abundance) of phytoplankton is to extract and measure the amount of photosynthetic pigments such as chlorophyll *a* and other phaeopigments in seawater samples (Valiela, 1984). Mean standing crop values for a site off Oahu were approximately 500 organisms wet weight per 100 m^2 between 0 and 400 m depths at night (Maynard et al., 1975). However, possibly due to an island effect, these data did not appear to be representative of open ocean systems. Previous studies in the vicinity of the Hawaiian Islands have found increased standing stock with increased distance from the island. In Hawaiian waters, productivity and standing stock values are highest between

100 and 400 m depth (Amesbury, 1975). Thus, considerable temporal and spatial variability occurs in the upper portions of the open ocean Hawaiian waters (Cattel and Gordon, 1971).

Letelier et al. (1993) describe phytoplankton community structure at an offshore station north northwest of Kauai. Species composition at this site was dominated by *Prochlorococcus* spp., cyanobacteria, prymnesiophytes, and chrysophytes. Although chlorophyll *a* values increased in spring at this site, no single phytoplankton species was predominant.

3.3.5.2 Zooplankton

Copepods and euphausiids, an important food source for many organisms, including juvenile fish, dominate the holoplankton in terms of numbers and biomass, although thalacians (salps), chaetognaths (arrow worms), and pelagic molluscs also are abundant. Common species in the Hawaiian Islands and Johnston Atoll include the mesopelagic mysid shrimp, *Gnathophausia longispina*, copepods of genera *Calanus*, *Neocalanus*, *Eucalanus*, and *Acartia*, and salps. Reid et al. (1991) collected 12 shrimp species and 3 squid species in micronektonic tows off Oahu. Similar species may occur in the vicinity of the Kauai and Johnston Atoll sites. Hatfield (1983) noted substantial differences in spatial distributions and abundances of a number of zooplankton species associated with upwelling, and seasonal and localized current patterns.

3.3.5.3 Ichthyoplankton

Ichthyoplankton (larval fish) are an important component of the zooplankton due to the importance of this group to commercial fishing and repopulating of local reefs. Reid et al. (1991) collected nine species of larval fish in nearshore plankton tows off Oahu, Molokai, Maui, and Hawaii, seven of which were myctophid species. However, Clarke (1991) collected larvae of over 50 families of nearshore fish off Oahu during 1977-78. The five most frequently collected families were wrasses (Labridae), sand perches (Parapercidae), basses (Serranidae), gobies (Gobiidae) and jacks (Carangidae). Similar species also may occur off of Kauai. A total of 12,777 fish larvae and 208 juvenile/adult fish, representing 64 families, were collected by Boettlert et al. (1992) off Johnston Atoll. These collections were dominated by myctophids, gobies, and bristlemouths.

3.3.6 SEABIRDS

Seabirds are defined as those species which obtain most of their food from the ocean and are found over water for more than half of the year (Briggs et al., 1987). Because the ATOC source would be located at approximately 850 m depth, and since the low frequency sounds generated are known to attenuate near the surface layer of the ocean and are not transmitted to the air (Figure 2.2.1.2-3), seabird species most likely to be affected are those that dive frequently to deep (greater than 20 m) depths.

The Hawaiian Islands support a diverse group of seabird species. Black-footed albatross (*Diomedea nigripes*) and Laysan albatross (*D. immutabilis*) occur within the general study area and have been recorded as breeders on Johnston Atoll. Other common species in the Kauai and

Johnston Atoll study areas include the Pacific golden plover or Kole (*Pluvialis fulva*), great frigatebird or Iwa (*Fregata minor*), wandering tattler or Ulili (*Heteroscelus incanus*), sooty tern or Ewa'ewa (*Sterna fuscata*), ruddy turnstones or Akekeke (*Arenaria interpres*), bristle-thighed curlew or Kioea (*Numenius tahitiensis*), wedge-tailed shearwater or Ua'u Kani (*Puffinus griseus*), red-footed booby or 'A (*Sula sula*), red-tailed tropicbird or Koa'e 'ula (*Phaethon rubricauda*), brown noddy or Noio Koha (*Anous stolidus*), and Bulwer's petrel or 'Ou (*Bulweria bulwerii*) (HAS, 1978). The Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*) and Newell's shearwater (*Puffinus auricularis newelli*) are also endemic seabird species.

Albatrosses are large seabirds that feed primarily on squid. Laysan and black-footed albatrosses have resident breeding populations on the larger Hawaiian Islands, and are under a protected status in accordance with the Migratory Bird Treaty Act. Thousands visit Midway Island each winter and spring, and are occasionally seen elsewhere on the northwestern Hawaiian Islands. These two species have been observed on Johnston Atoll prior to 1962 (Amerson and Shelton, 1976). The historical range of the short-tailed albatross includes Hawaiian waters, and the current worldwide population is only about 400 birds, including approximately 85 breeding pairs.

In general, shearwaters, noddies and petrels use many of the Hawaiian Islands for roosting and nesting. Migratory seabirds such as ruddy turnstones, wandering tattlers, and Pacific golden plovers forage for food on the shorelines.

The Kilauea Point National Wildlife Refuge on Kauai contains the largest seabird colony in the main Hawaiian Islands. The refuge is home to Laysan albatross, wedge-tailed shearwaters, red-footed boobies, brown boobies, great frigate birds, red-tailed tropic birds, and white-tailed tropic birds.

Fifty-six bird species, belonging to 10 orders, 19 families, and 38 genera have been reported from Johnston Atoll (Amerson and Shelton, 1976). Of these 56 species, 22 have been observed on the atoll. Of these 22 species, 12 are breeders; three species, such as the black-footed and Laysan albatrosses are former breeders, and seven species, including the Phoenix petrel, sooty storm petrel, red-tailed and white-tailed tropicbirds, and the blue-gray noddy are considered visitors. Of the above species that dive in pursuit of their prey, all are thought to be shallow water divers, capable of diving to depths of less than 20 m. No known deep-diving bird species occur in the Kauai and Johnston Atoll study areas.

3.3.7 THREATENED, ENDANGERED, AND SPECIAL STATUS SPECIES

This section presents information on threatened, endangered, and special status species that may occur in the study area. Summary information on species status, abundance, and some general life history is also included. Table 3.3.7-1 lists the threatened, endangered and special status species that may occur in the study area.

Table 3.3.7-1. State of Hawaii threatened, endangered, and special status species.

Common Name	Scientific Name
right whale	*Eubalaena glacialis*
blue whale	*Balaenoptera musculus*
fin whale	*B. physalus*
humpback whale	*Megaptera novaengliae*
sperm whale	*Physeter macrocephalus*
Hawaiian monk seal	*Monachus schauinslandi*
green sea turtle	*Chelonia mydas*
leatherback sea turtle	*Dermochelys coriacea*
olive ridley sea turtle	*Lepidochelys olivacea*
hawksbill sea turtle	*Eretmochelys imbricata*
Newell's shearwater	*Puffinus auricularis newelli*
black-footed albatross	*Diomedea nigripes*
Laysan albatross	*D. immutabilis*
short-tailed albatross	*D. albatrus*
Hawaiian dark-rumped petrel	*Pterodroma phaeopygia sandwichensis*

All of the species listed have either been observed in or around Hawaiian waters, or occur within the study areas (including Kauai and Johnston Atoll). With the exception of humpback whales, most of the threatened or endangered marine mammals would occur infrequently, if at all, in the vicinity of Johnston Atoll.

Approximately 15 threatened, endangered, or special status marine species may occur within the study areas (including Kauai and Johnston Atoll) (Amerson and Shelton, 1976; Drevenak, pers. comm., 1994). These include four mysticetes (blue, fin, humpback, and right whales), one odontocete (sperm whale), one pinniped (Hawaiian monk seal) four sea turtles (leatherback, green, olive ridley, and Pacific hawksbill turtles), and five seabird species (Newell's shearwater, black-footed albatross, Laysan albatross, short-tailed albatross and the Hawaiian dark-rumped petrel).

3.3.8 MARINE SANCTUARIES AND SPECIAL BIOLOGICAL RESOURCE AREAS

The Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) was Congressionally designated by the Oceans Act in November of 1992. The Sanctuary specifically recognizes the importance of humpback whales and their winter habitat. One of the sanctuary goals is to gain an accurate description of the total North Pacific humpback population and the number of individuals wintering in Hawaiian waters.

The sanctuary was established to provide a mechanism to develop research protocols, allowing for the whale research community and NMFS to work closely together. The sanctuary includes the area from the highwater mark to water depths of approximately 183 m around the islands of Mauai, Lanai, and Molokai; Penguin Bank; and a small portion off Kauai's Kilauea Point National Wildlife Refuge on the north coast.

The Kilauea Point National Wildlife Refuge on Kauai contains the largest seabird colony in the main Hawaiian Islands. It is administered by a resident U.S. Fish and Wildlife Service (FWS) representative.

Johnston Atoll was established as a federal bird refuge in 1926, in recognition of large numbers of breeding and nesting birds which inhabit the atoll. At least half a million seabirds use the atoll for roosting and nesting, with species such as the sooty tern or ewa' ewa (*Sterna fuscata*) being most abundant. Today, Johnston Atoll is a National Wildlife Refuge administered by a resident U.S. Fish and Wildlife Service (FWS) representative (EPA, 1985).

3.3.9 BIOTA ALONG CABLE ROUTE

The cable route at the Kauai site extends over island shelf and slope habitats and shallow, sandy bottom subtidal areas (as shallow as 24 m). Regional geography and geology for the Kauai and Johnston Atoll sites was previously described in Section 3.2.5. Biota in these areas is highly dependent on the subsea geology and geography described in these sections. The cable route crosses only one reef, offshore from Barking Sands, passing through surge channels in the reef. After crossing the reef area, the cable lies on sand and soft-bottom areas.

Shallow nearshore communities (depths 24-50 m) likely are characterized by a variety of fish families, including wrasses (Labridae), goatfish (Mullidae), and damselfish (Pomocentridae). Species within these families comprise complex coral reef communities. Invertebrates likely to occur at these depths include lobster, crab, sea stars, and sea urchins. Reef-building corals likely will dominate the shallow subtidal areas.

In water depths ranging between 45 and 67 m, the cable crosses the outer face of the offshore reef. This part of the reef is dissected by frequent surge channels, which can be characterized as having similar abundances and diversity as nearby adjacent reefs.

Deeper shelf and slope communities can be characterized as moderately diverse habitats. Fish such as tunas, jacks, and scad will predominate. At deeper depths (over the island shelf and slope) off Kauai and Johnston Atoll, sandy bottom species such as rattails, skates, and cod-like fish predominate (Chave and Mundy, 1994).

3.4 ECONOMIC ENVIRONMENT

3.4.1 COMMERCIAL, RECREATIONAL, AND POTENTIAL FISHERIES

Expansion and diversification of pelagic fisheries and growth in some recreational fisheries led to overexploitation of many fishery stocks in Hawaiian waters during the late 1980's and 1990's (Pooley, 1993). However, recent changes in Hawaiian commercial fisheries, such as reduction in limited entry of permits for bottomfish and lobster, moratoria to new longline fishermen, closed seasons and quotas for lobster, and some area closures have improved some fisheries (Pooley, 1993). All of the above changes are aimed at preserving Hawaiian fisheries.

Hawaii's commercial fishery exceeded $50 million in ex-vessel revenues in 1990, based on a total catch of over 22 million pounds (approximately 10 million kg) (Pooley, 1993). The longline tuna fishery accounted for nearly $29 million of this total. During calendar year 1993, Kauai fishermen caught 17,050 kg of fish in Fisheries Statistical Area No. 523, which encompasses the area offshore of the north Kauai coast. Approximately 15,615 kg were caught by trollers and 1255 kg by bottom fishermen (DLNR, 1994).

Most of the commercial fishing in Hawaii is conducted on the submerged shelves, banks, and slopes of the populated islands and the northwestern Hawaiian Islands. Some of the seamounts in the vicinity of the study area support limited fisheries, with substantially less commercial value than nearshore reef areas (MMS, 1987). Although commercial fishing occurs offshore of nearly all the Hawaiian Islands (including Kauai), none (except the rare tuna fishing boat) occurs in the offshore waters near Johnston Atoll (MMS, 1987).

Off Kauai, nearshore fisheries target a variety of fish such as bigeye scad, goatfish, surgeonfish, and squirrelfish. These species are easily accessible in small boats throughout the island. A significant fishery for white crab or Kona Crab exists off Niihau (Smith, 1993).

The most commonly caught commercial bottomfish in Hawaii are several species of snapper, grouper, and jacks (Pooley, 1993). Lobster are the primary epifaunal invertebrate collected commercially. Pelagic fisheries off Hawaii include marlin, swordfish, sailfish, mahi mahi, and several tuna species. Pelagic sharks also comprise a significant part of the commercial catch, with blue sharks, mako, and threshers taken in the highest numbers.

Hawaii's nearshore fisheries are quite productive; however, a deepwater fishery also exists for snappers and some tuna (Haight et al., 1993). In fact, the nearshore fisheries produce only a small fraction of the total catch as reported from Hawaiian fisheries on an annual basis (Diaz-Soltero, pers. comm., 1995). Some invertebrates, such as pandalid shrimp are collected in commercial traps at depths between 350 and 825 m. At these deeper depths, some species of black coral are taken by commercial divers for the coral jewelry industry (Grigg, 1993; Grigg pers. comm., 1994). Black coral is taken by commercial divers off Maui and off the west and southern coast of Kauai. However, it is unlikely that black coral is taken in the Kauai study area.

The distinction between recreational and commercial fisheries in Hawaii's small boat fleets is extremely difficult. This is due to the fact that many commercial fishermen hold full-time and part-time jobs which provide more income than fishing (Pooley, 1993). Furthermore, charter boat captains usually retain their catch for sale at local markets. These issues have lead to many problems in compiling recreational fishery data.

3.4.2 MARICULTURE/AQUACULTURE

Mariculture, or aquaculture, is the farming of aquatic or marine organisms, such as fish, molluscs, crustaceans, and algae. It is currently one of the fastest growing industries in Hawaii, with an annual growth rate in revenues of nearly 13% and an estimated income of over $21 million in 1989 (DLNR, 1990). The variety of organisms raised through aquaculture has increased steadily since 1979, currently representing over 35 different species, including marine shrimp, Chinese catfish, tilapia, carp, rainbow trout, abalone, nori, ogo, spirulina, oysters, salmon, and lobster (DLNR, 1990). Potential new species include mahi mahi, Japanese flounder, baitfish, giant clams, limpets, and sea cucumbers. However, no aquaculture facilities are presently operated on Kauai, or Johnston Atoll (EPA, 1985).

3.4.3 SHIPPING

The Hawaiian Islands serve as a major port for international shipping, with over 91.2 million tons (82.7 billion kg) of freight worth over $124 billion moved between the U.S. West coast, Alaska, Hawaii, and Far East ports in 1987. Of this, about 22.4 million tons (20.3 billion kg) were handled through Hawaiian ports (Corps of Engineers, 1989). This shipping activity involved 21,325 vessel arrivals and departures from Hawaiian ports.

The two major shipping ports of Kauai are Nawiliwili and Port Allen. Vessel arrivals for 1989 were 1079 for Nawiliwili and 100 for Port Allen (COE, 1991). Freight traffic (tons) for Nawilili for the 5-year period 1985-89 was as follows: 1985 (933,477), 1986 (745,396), 1987 (916,422), 1988 (875,753), and 1989 (1,038,452) (COE, 1991).

3.4.4 MILITARY USAGE

The Pacific Missile Range Facility (PMRF) is the largest federal government employer on Kauai, with approximately 850 workers, including tenant organizations and civilian contractors (Pham, 1991). The total annual expenditures for PMRF, tenant organizations, and contractors was $72.5 million for 1990. PMRF had a FY 1991 operating budget of $50.1 million, including a payroll of $29.6 million.

Since 1936, Johnston Atoll has been utilized under an U.S. Air Force plant account and field command of the Defense Nuclear Agency. In addition to being an air station during early World War II, patrol submarines used the atoll as a refueling base (Amerson and Shelton, 1976). In 1959, the U.S. Coast Guard started construction of a LORAN-A and -C station on Sand Island and by 1961, the facility was operational. Most recently, the atoll has become the storage site for obsolete chemical warfare agents, including nerve gas and herbicides used in southeast Asia. These agents were placed downwind in a security area on the southwest end of Johnston Island. The atoll presently is a Naval Defensive Sea Area and Air Space Reservation.

The U.S. Navy's Pacific Fleet, including a variety of ships and submarines is stationed in Hawaii. No daily estimates for the number of ships or submarines likely to occur in the study region are available (P. McClaran, PMRF, pers. comm., 1994); however, based on general activity levels, it can be assumed that ship and submarine traffic in the vicinity of the Kauai and Johnston Atoll sites varies between low and moderate activity levels.

3.4.5 MINERAL OR ENERGY DEVELOPMENT

The most valuable offshore marine minerals resources in the general region of the Hawaiian Islands and Johnston Atoll are cobalt-rich manganese crusts and nodules. The existence of these types of resources on Pacific seamounts has been recognized for at least 20 yrs (HDBED, 1987). Recent surveys, although preliminary in nature, indicate a large potentially exploitable resource in various deep-water (800-2400 m) regions off the Hawaiian Islands and Johnston Atoll. Manganese crust coverage within these areas ranges from 0% (areas of thick sediment cover) to 100% (areas of thick crust "pavements"). Coverage for the Hawaiian axis (i.e., nearly 200 km south of Kauai) is approximately 25%, while other areas average nearly 40%. Manganese nodules, which are relatively rich in manganese, cobalt, iron, nickel, and copper, are abundant over vast areas of the seabed at depths between 4000 and 5000 m (HOMRC, 1991).

Initial survey results indicate that little, if any, manganese mining would occur in the vicinity of the proposed action site due to its low crust coverage. In contrast, crust coverage off Johnston Atoll is slightly higher than Kauai and could be utilized as a potential managanese mining site (HDBED, 1987). No marine mineral mining activities are scheduled to take place in the Hawaiian Islands or Johnston Atoll at this time.

3.4.6 CULTURAL AND HISTORICAL RESOURCES

There are no known cultural or historical resources within the Kauai study area. The State Department of Land and Natural Resources does not maintain information concerning shipwrecks.

In "pre-contact" Hawaii (prior to 1778), temporal rule of the islands was divided among a number of alii, or chiefs. Each of these had, in theory, unrestricted control over all the resources within his moku or districts (Meller, 1985). The ahupuaa in which the moku was subdivided, usually had attached to them ocean fishing rights, in some instances not only adjacent to their own shores, but spreading out on each side up and down the coast for many miles (Cobb, 1908). Thus, the alii controlled all fishing rights in their jurisdiction.

Managing the apupuaa were the konohiki or agents of the alii. The konohiki collected a portion of the harvest of both land and ocean resources on behalf of the alii from the hoaaina or tenants, and placed limitations on the uses of the resources, depending on environmental conditions (Meller, 1985).

The U.S. Congress attempted to extinguish all konohiki fishing rights in the Organic Act of 1900. Section nine of the Act provided for a 2-year period in which the owners of konohiki rights could register claims to a konohiki fishery with the Territorial Courts, or forfeit all claims to those rights (Meller, 1985). Once the claims were filed, it was the intent of the federal and territorial governments to acquire all rights to the registered konohiki fisheries through condemnation (Clay et al., 1981).

There is some uncertainty as to the total number of konohiki fishing areas and how many were registered before 1903. Meller (1985) estimates between 363 and 720 areas existed, but noted that opinions vary on how many were registered, from a low of about 100 to a high of 144. Because of this uncertainty in the number of registered rights, there is no exact figure as to the number in existence today. Khil (1978) puts the estimate for Kauai as follows: number registered, 9; number condemned, 7; number outstanding, 2. These two are both located on the south shore, at Wahiawa and Omao.

In 1941, Johnston Atoll was shelled from offshore Japanese ships. One Japanese submarine was reported sunk by land guns (Amerson and Shelton, 1976). No other cultural or historical resources are known to occur on or offshore Johnston Atoll.

3.5 SOCIAL ENVIRONMENT

3.5.1 RECREATIONAL ACTIVITIES AND TOURISM

Kauai's economy is dominated by tourism and agricultural industries. Government employment is also a major contributor to the local economy, as discussed in Section 3.4.4.

The tourism industry and associated travel-related services employ approximately 16,000 people on Kauai (Pham, 1991). Average earnings per job in this industry was approximately $17,900 in 1990 (Pham, 1991). The Hawaii Visitors Bureau (1991) estimated that 1.3 million people visited Kauai in 1990. Visitor expenditures for 1990 were approximately $945 million (Hawaii Visitors Bureau, 1991).

According to Townsend (1991), the major recreational activities on Kauai are fishing, boating, diving, snorkeling, surfing, waterskiing, whale-watching, sea kayaking, parasailing (commercial), and riding pleasurecraft (private and commercial). In 1988, the Hawaii Department of Transportation issued regulations limiting commercial pleasurecraft and parasailing operations. Whale-watching operations are subject to federal regulation with respect to humpback whales. At least three whale-watching vessel-types are in operation off Kauai:

- M/V Napali Queen; 28 m length overall; does not anchor in Hanalei Bay
- Power catamarans; 12 m length overall; two 200 hp outboard motors; anchor in Hanalei Bay
- Zodiac inflatable boats; approximately 3-5 m length overall; launch and recovery operations at the mouth of the Hanalei River

Economic activities involving the ocean in Hawaii are highly diversified including tour boats, interisland cruises, charter boat and recreational fishing, yacht racing, competitive ocean swims, Hawaiian canoe races, and wind-, board-, and body-surfing events. Total direct revenue estimates for 1992 were estimated at nearly $ 560 million (MacDonald and Deese, 1994).

No official tourism or recreational activities occur at Johnston Atoll, primarily because of military use of the atoll. Due to its remote location, essentially no commercial fishing occurs in the area, although tuna boats occasionally fish the general region (EPA, 1985).

3.5.2 RESEARCH AND EDUCATION

Ocean research and education is extremely important for long-term success of the Hawaii Ocean Resources Management Plan. While most of the research and education activities in Hawaii are centered on Oahu, new marine resource centers and research facilities are being established on or are planned for the neighbor islands (HOMRC, 1991). The only college-level facility presently on Kauai is Kauai Community College (KCC). While KCC does not specialize in marine research, many local public school systems have formal marine education programs.

Modern support facilities at several locations in the Hawaiian Islands, primarily on Oahu, provide researchers with an extensive infrastructure for services such as satellite communication and tracking, marine laboratory analyses, marine surveying and brokering, and ship maintenance facilities. Other institutional facilities for marine research are associated with the U.S. Navy, the University of Hawaii's School of Ocean and Earth Science and Technology, the Law of the Sea Institute, and various federal government agencies, including Marine Minerals Technology Center (DOI), the Pacific Mapping Center (DOC/DOI), and the Center for Tropical and Subtropical Aquaculture (DOA). Most of these facilities are located on Oahu and the Big Island (NOAA, 1994).

Preliminary discussions have been held with the University of Hawaii's Office of Technology Transfer and Economic Development (OTTED) to potentially link the MMRP into Department of Education programs. This could be in the form of audio-visual presentations to selected academic institutions focusing on biological oceanography, marine mammals as ecological indicators, and the marine mammal populations in the area. Other areas of technical inquiry and education include the use of passive acoustics as non-invasive marine mammal detection and tracking devices, and the potential for underwater acoustics in environmental assessment programs. The potential for establishing direct data relay lines to educational institutions also has been discussed.

The potential for networking the marine mammal data collected under the MMRP into the Maui Supercomputer via the Cornell University Theory Center also will be explored. This would allow the University of Hawaii direct access to the information through OTTED, which has an office at the Maui Research and Technology Park facility where the supercomputer is located.

No formal educational facilities exist on Johnston Atoll; however, this site has functioned as a research facility for numerous agencies, most notably the U.S. Fish and Wildlife Service (FWS). Studies conducted by the Smithsonian Institution's Pacific Ocean Biological Survey Program (POBSP) have increased the amount of information on resident and migratory bird populations. Other studies on Johnston Atoll have focused on the effect of human alteration, such as dredging operations on coral reef communities (Amerson and Shelton, 1976).

3.5.3 WATER CONTACT SPORTS

Shoreline usage and water contact sports are highly important activities for Hawaii's residents and many tourist industries (HOMRC, 1991). Based on 1985 State Comprehensive Outdoor Recreation Plan (SCORP) statistics, at least 170,000 people swim or sunbathe at beaches or shorelines daily. Further, other daily usage includes almost 23,000 surfers, 25,000 fishermen (from onshore and boats), 3000 canoers and kayakers, 18,000 boaters, and more than 21,000 scuba divers (HOMRC, 1991). Other popular water sports include windsurfing, sailing, and catamaran sailing. Diving and snorkeling are some of the most popular recreational activities in Hawaii, mostly occurring around inshore coral reefs.

Generally, the north coast beaches off Kauai are the best for swimming, snorkeling, and diving in summer, and surfing in winter. Better conditions for swimming and snorkeling along the south coast occur in winter. Many locations on the north coast offer safe swimming, snorkeling, and diving, including Kalihiwai Beach Park, Ke'e, Hanalei Bay, Anini Beach, Haena, and Moloaa (Sunset Book, 1975). Some of the most popular areas on the south coast of Kauai for diving and snorkeling include Poipu Beach, and Kukuiula (AAA Tour Book, 1992).

No known water contact sports occur off Johnston Atoll. However, snorkeling and diving by researchers likely occurs in the shallow nearshore and lagoon areas.

4 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This section forms the scientific and analytical basis for comparison of alternatives in Section 2 and the affected environment descriptions presented in Section 3. It describes the potential consequences of the four alternatives on a range of environmental resources. Unless otherwise indicated, the effects on marine animals of the "no action" alternative are presumed to be inconsequential. The section is organized first by resources (i.e., physical environment, biological environment, and socio-economic environment), followed by a discussion of minor and secondary effects in a section on "other impacts."

Each subsection analyzes the potential effects of the four alternatives, both individually and cumulatively. Cumulative impacts are those impacts on the environment which result from the combined impact of the action when added to other past, present, and reasonably foreseeable future actions. Mitigation measures for each impact are identified, where applicable.

4.2 POTENTIAL EFFECTS ON THE PHYSICAL ENVIRONMENT

This section considers the potential effects of the four alternatives (Alternative 1, Proposed Action; Alternative 2, No Action; Alternative 3, Alternate Project Site -Johnston Atoll; Alternative 4, Moored Autonomous Sources) on the physical environment. Such effects include potential disturbance of the seafloor through installation of MMRP or sound source facilities, and the increase in noise levels that would occur during source operations. The potential impacts of the sound source on biological resources are discussed below in Section 4.3.

4.2.1 POTENTIAL DIRECT AND INDIRECT EFFECTS ON THE PHYSICAL ENVIRONMENT

4.2.1.1 Construction of Facilities

Direct physical impacts of the project facilities installation would be considered important if they could lead to problems with regard to slope instability, safety or other hazards (including hazards to navigation), threat of release of hazardous substances, or other incompatibilities with the physical environment.

The physical installations associated with the project are relatively minor and generally are benign from an environmental standpoint. Alternatives 1 and 3, the proposed installation off the north shore of Kauai and Johnston Atoll, respectively, would involve the placement of a small sound source with a footprint of 4.7 m^2 on the seafloor, with no alteration of the seafloor contours. For the Kauai location, the cable connected to the source would lay on the seafloor with no physical alteration to the seafloor contours. No new cable installation would be placed through the surf zone, since that cable would be connected to an existing sea-shore interface several kilometers from shore.

For the Johnston Atoll alternative, the cable would need to be laid through the shoreline band, with associated trenching (nominally 1 m deep) and the installation of a pipe that would protect the cable from wave action and prevent movement. Even this installation, however, would be comparatively minor and would not result in major physical effects on the environment.

Likewise, the moored autonomous source alternative (Alternative 4) would have a low impact on the physical environment, since it would have a small seafloor footprint, would involve no alteration to the bottom, and would not have an associated cable installation. There would be a minor risk that the batteries necessary to support such a source would leak over time, particularly if recovery of the source were not possible at the end of its life. This could introduce small quantities of potentially toxic chemical components into the ocean; however, they should be neutralized quickly in seawater.

Mitigation Measure 1-1: For the Johnston Atoll alternative, the portions of the ATOC cable and any protective casing in the nearshore area and surf zone would be designed to minimize the potential for adverse impacts.

Mitigation Measure 1-2: Project facilities would be removed at the end of the experiment, to the extent economically and practicably feasible.

4.2.1.2 Noise

Generally HEPA identifies noise impacts as those that result in a substantial increase in the ambient noise levels for adjoining areas. Marine biologists consider some negative effects due to present-day ocean noise pollution may already be occurring to marine mammals. The potential for impacts also exists where land use compatibility standards, such as those defined by the State of Hawaii, are exceeded.

Within the study area, there are no applicable subsea noise standards. Most community noise standards are based upon average measurements (Hirschorn, 1982) that may weigh various time periods differently (such as nighttime hours) due to the relatively greater sensitivity of the human population exposed to the noise at those times. For determining the significance of the noise from the project source, a long-term average, Level-equivalent (Leq) measurement is considered by some scientists as appropriate (Malme et al., 1989; Ellison et al., 1993) since the source operation would not emphasize any time of day or night, and there is no indication that particular hours are of relatively greater concern in the marine environment (although many animals exhibit diurnal activity patterns). This approach is based on long-term average measurements, and is commonly applied to human occupational noise exposure situations.

An estimate of the net Leq of a given sound source can be derived from the following formula:

$$Leq(T) = RL + 10Log_{10}(t/T)$$

where: T = Leq measurement period
RL = Received Level of sound field at animal
t = duration of signal during the time period T

For example, using the 120 dB sound field (at 2% duty cycle) elicits the following result:

$$Leq(4\ days) = 120 + 10Log_{10}(120\ min/5760\ min) = 120 - 17 = 103\ dB.$$

Thus, exposure to the 120 dB sound field over a 4-day period (the signal being transmitted 120 min out of the total 5760 min) equates to continuous exposure to a 103 dB sound field over the same 4 day period. As is shown in Section 3, this value is relatable to high broadband ambient noise levels that could be expected in the study area. During the 2-8% of the time the source is transmitting, received levels in the 57.5 - 92.5 Hz frequency band should decrease to < 88 dB in the sound channel within 500 km.

The MMRP includes components in both Hawaii and California to evaluate the validity of this assumption. This work will include the attempted development of low frequency audiograms for species of concern and additional measurement of subsea noise (received levels) on an Leq basis to allow comparisons to sound source operations (see Appendix C). Section 3 of this EIS provides noise data for the study area.

Habitat uses by marine organisms and oceanographic acoustic research are the primary noise-sensitive uses in the project vicinity. Other oceanographic research efforts and U.S. Navy activities would be coordinated through Scripps to avoid interference. No human land use incompatibilities or corresponding noise impacts are presented.

Mitigation Measure 2-1: The duty cycle and power levels of the source would be adjusted to the minimum necessary to support research objectives, and the source would be shut down if any of the acute or short-term responses in Table C-1 are observed in relation to source transmissions.

Mitigation Measure 2-2: The ATOC project would coordinate with other oceanographic and acoustic research efforts, and U.S. Navy activities, and the commercial fishing industry, to ensure that scheduling and operational conflicts are avoided.

In terms of the sound fields of the fixed sources, all alternatives except the "no action" alternative would add somewhat to the ambient noise levels in the vicinity of the sound source (during transmission periods). MMRP vessels and aircraft would also add somewhat (on an intermittent basis) to ambient noise levels. See Potential Cumulative Effects Sections 4.3.1.1.2, 4.3.1.2.2, 4.3.1.3.2, 4.3.2.1.2, 4.3.2.2.2, and 4.3.2.3.2, and responses to comments in Appendix F.

4.2.1.3 Other Potential Physical Impacts

Source installation and operation at any of the site alternatives would have no adverse effect on any water column characteristics (temperature, salinity, or dissolved oxygen), or on the regional geology (sediments, seismicity, or bathymetry).

4.2.2 POTENTIAL CUMULATIVE EFFECTS ON THE PHYSICAL ENVIRONMENT

The National Environmental Policy Act (NEPA) defines a cumulative impact as: "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time."

Other than potential general increases in vessel traffic through the project vicinity, and onshore development of various kinds, no other human activities (past, present, or future), or natural sounds are anticipated to cumulate with the acoustic thermometry source transmissions and MMRP activities. Specifically, a single ATOC source should provide adequate coverage from mid-Pacific to receivers in the eastern and North Pacific, and additional sources should not be required at any mid-Pacific location. Any cumulative effects of past, current, and future human activities (e.g., whale-watching, fishing, pleasure boating, etc.) with the short duty cycle source transmissions are expected to be minimal. No other new sound sources or similar facilities currently are proposed for the project area. Similarly, the north Kauai area is not a likely site for new commercial or other subsea cable installations, and development restrictions along the north Kauai coast are likely to prevent substantial future large-scale onshore development. As a result, no major development of facilities similar to or related to the project cable and onshore equipment installations are anticipated.

As discussed above, the effects of the cable installation on the physical environment (for Alternatives 1 and 3) are expected to be minimal. Thus, it is not anticipated that this action, when added to other past, present, and reasonably foreseeable future actions, would result in cumulative impacts. Noise from the sources would be expected to add to the ambient noise levels in the vicinity of the sources (intermittently during the 2-8% of the time the source would be transmitting). Other sources of noise which contribute to the ambient noise levels are either natural (e.g., wind, waves, marine life, seismics) or human-related (e.g., from vessels, aircraft, and onshore and nearshore construction). The potential cumulative effect of noise produced by MMRP aircraft and vessels during the course of research conduct would be negligible, constituting less than 0.01% of the total overall ambient noise in the study area throughout the Pilot Study. While human-related sources of noise may increase over time with increases in population, economic activities and resulting traffic levels, any such increase is speculative.

4.3 POTENTIAL EFFECTS ON THE BIOLOGICAL ENVIRONMENT

This Section discusses the potential impacts of the five alternatives (including the proposed action) on marine mammals and sea turtles, as well as on fish, invertebrates, plankton, and seabirds.

The effects of noise on marine animals have not been studied extensively. The lack of information is particularly acute regarding large whales, which are difficult to study in the wild, and on invertebrates. In many areas, potential impacts must be inferred from incomplete data. The following Sections must be reviewed with this caveat in mind.

Generally speaking, a range of potential impacts can be summarized as follows:

Death or Injury: The potential for death to any marine mammal or sea turtle as a result of the proposed research is considered nonexistent. The potential for death or injury with respect to other animals (e.g., fish) is unlikely, but is possible at sound levels ≥180 dB (8 m range from source) (Hastings, 1991). However, any lethal impacts to fish would be indirect (due to ramp-up period) and result from the potential increase in predation on fish in the immediate vicinity of the source (i.e., <8 m range). There would be no direct lethal effects on any marine animals.

Direct Damage to Hearing Receptors: At the extreme end of the range of hearing impacts 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). Based on analysis of available data (Section 4), no direct damage to hearing structures of marine mammals or sea turtles is expected from this project (see Section 4.3.1.1.1).

Permanent Threshold Shift: A permanent threshold shift or PTS is, as the name suggests, an increase in the threshold of hearing that is permanent, not temporary. It is an unrecoverable deafening that does not diminish with time. PTSs generally occur as a result of long-term exposures and/or extremely loud noises. Repeated exposures to any signal strong enough to cause temporary threshold shift (TTS)-level stimuli can induce PTS, as well. Based on analysis of available data (Section 4), no PTSs to marine mammals or sea turtles are expected from this project (see Section 4.3.1.1.1).

Temporary Threshold Shift: Temporary threshold shift, or TTS, is an increase in an individual animal's hearing threshold in response to a loud sound. All humans typically experience such shifts directly, such as the effect that occurs after leaving a noisy room to a quiet location. For a period of time, the threshold of hearing is increased such that quiet sounds are not perceived. A TTS slowly dissipates so that original hearing abilities return. TTSs generally occur at sound intensities well above threshold hearing levels. In humans the difference between the threshold of hearing and sound intensities that result in TTS is approximately 80 to 100 dB. Based on analysis of available data (Section 4), TTSs are only anticipated for animals venturing very close (within approximately 100-200 m) to the ATOC source.

Behavioral Disruption and Habituation: Sounds can result in behavioral changes in movement patterns that may 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. Infrequent and minor changes in movement directions, for example, may be completely benign, while more frequent or recurrent incidents of interrupted feeding and rapid swimming, if sufficiently frequent and of prolonged duration (e.g., bowhead whales have stopped feeding and fled from approaching boats [Richardson et al., 1986]), could have negative effects on individuals. Behavioral changes generally are detected at sound intensities higher than the levels at which the sounds would be barely detectable or perceivable to a marine animal.

Animals that appear to tolerate human-made noise are presumed to be less affected by a noise source. In some cases, this can be attributed to habituation--the potential for an animal over time to become less sensitive to certain types of noise and disturbance to which they repeatedly are exposed and which they come to perceive as non-threatening. However, the presence of marine mammals in an ensonified area does not prove that the population or individual therein is unaffected by the noise, as they may stay in the area despite the presence of noise disturbance if there are no alternative areas that meet their requirements (Brodie, 1981b).

Masking: All marine animals have a threshold level below which they cannot hear. In the environment, this threshold is determined by the higher of two levels--the ambient noise level surrounding the animal or the limits of their physical ability to hear. In other words, animals cannot hear sounds that are less intense than background noise at similar frequencies, and sound louder than background levels can only be heard if the animal is physically capable of doing so. Increases in ambient noise will increase the threshold intensity for detectable sounds (for those animals whose hearing threshold is below those ambient levels). This effect is commonly known as masking. Masking of significant sounds (e.g., calls of other animals, predators, prey, sounds of hazards, such as approaching boats, etc.) can occur when the ambient noise levels at similar frequencies increase.

Marine mammals are believed to be well-adapted to coping with a naturally noisy and variable ocean environment, and likely have tolerance to some increase in masking relative to natural and human-made levels. However, the thresholds of this tolerance currently are unknown and cannot be determined until there is a better understanding of: 1) the vital functional importance to mammals 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 of emitted sounds to minimize masking. It is probable that localized or temporary increases in masking normally cause few problems for marine mammals, with the possible exception of populations that are highly concentrated in an ensonified area. However, a more extensive and continuous noise field could result if a number of noise sources were distributed through a major part of the range of a marine mammal population. Masking might be more of a problem in such cases (Richardson et al., 1991).

All of the impact discussions below evaluate potential impacts of underwater exposures. It is not anticipated that any impacts would occur as a result of sound transmissions received in air by animals at the surface (e.g., albatrosses, or monk seals with their heads out of the water) because the maximum possible received level would be only 74.5 dB directly over the source, and this level would be attenuated even further by the water/surface interface (i.e., by at least 5-10 dB). It is not anticipated that any animals would respond directly to noises of this magnitude.

Scientific Uncertainty

As stressed in this EIS, available information on subsea noise and its biological impact in many cases is incomplete to nonexistent, depending on the species being considered. The NEPA Guidelines (40 C.F.R. § 1502.22) state that if there is incomplete or unavailable information regarding "reasonably foreseeable significant adverse effects" and that information is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the information is to be obtained and included in the EIS. If relevant information concerning potential adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency is to include in the EIS: 1) a statement that such information is incomplete or unavailable; 2) a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; 3) a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment; and 4) the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. All of the above are included in this EIS.

As set forth below, the ATOC project and MMRP are not anticipated, in most cases, to result in potentially significant impacts on biological resources. This conclusion is based on available information regarding the species potentially affected, which is analyzed in this Section. In some cases, the lack of available data necessitate a finding of uncertain, as to whether impacts are expected.

Potential impacts on biological resources also are limited by the relative temporary nature of the initial ATOC and MMRP experimental activities, which will span at most a two-year period of transmissions, and the limited duty cycle of the ATOC source (on 2% of the time, off the remaining 98%, for most of the experimental period). It also is limited by the fact that relatively few of the marine mammals that could inhabit the study area are known to dive to depths that would put them in proximity to potentially harmful sound fields.

For many marine animals, the means of obtaining additional information on adverse effects are unknown, and/or the costs high. The ability to obtain information concerning hearing capabilities and impacts of subsea sounds is in most instances limited by the nature of the animals involved. Large whales only can be studied in the wild, often are rare and difficult to approach, or even find. Therefore, to date, hearing abilities have not been measured directly but instead must be inferred. At the other end of the spectrum, many of the animals are small, or even microscopic, and include invertebrates and other animals that often provide no measurable indication of hearing perception or acoustic impacts. The sheer number of species also would render a comprehensive survey exorbitantly expensive and unwieldy. The MMRP has been designed to obtain much-needed information (Appendix C).

This EIS contains an expansive analysis and implements the directives of the NEPA guidelines listed above, acknowledging the lack of information, stating its relevance to the analysis, summarizing existing evidence, and evaluating the impacts based on available information. As an integral part of the MMRP, an attempt will be made to fill several of the gaps in available information concerning a number of species of concern, so that future decisions concerning any long-term ATOC activities can be made based on an improved information base.

In addressing the ATOC project and MMRP, one of the costs/benefits that must be weighed in the EIS is the cost of uncertainty--the costs of proceeding without more and better information. The ATOC project itself is intended to fill information gaps and reduce uncertainty concerning the global warming question. The associated MMRP, while designed to assess and evaluate potential efects of ATOC low frequency sound transmissions, it is expected to result in greater knowledge of low frequency sound impacts in general.

4.3.1 MARINE MAMMAL SPECIES

This Section pertains to marine mammals in the north Kauai coastal region: mysticetes (four baleen whales, including humpback whales), odontocetes (16 toothed whales), and one pinniped (Hawaiian monk seal). It presents information on: the ability of mysticetes, odontocetes, and pinnipeds to hear and produce low frequency sounds; the potential behavioral and physical auditory effects of low frequency noise on various species; and the potential cumulative impacts of noise from the proposed alternatives in combination with other human-related noise and activities. Conclusions are provided on the potential effects of the four alternatives based on the currently available data.

Because data concerning marine animal stock structure (i.e., sub-units) and population delineation are incomplete for many, if not all, of the marine animal species addressed in this EIS, most of the discussions in this section involve the potential effects low frequency sound transmissions could possibly have on a specific species, based on that species' pertinent distribution and abundance, and known behavioral patterns, rather than a particular stock or sub-unit that may inhabit the proposed study area. There is no distinction of relative significance among an individual animal, a sub-group, or a species as a whole, and the shut-down guidelines (Appendix C) reflect this. If the MMRP goes forward, by virtue of its designated focused study area around the proposed source site, population sub-units or stocks local to north Kauai (or at least the Hawaiian Islands) would necessarily be the focal animals/sub-units used in assessing the significance of potential adverse impacts on marine animals. The best available estimates of the stock of marine mammal and sea turtle species that would be expected to reside or pass through the general EIS study area during the course of the proposed two-year MMRP are listed in Section 3.3.1. MMRP population distribution and abundance data collected would supplement these estimates and support future efforts using population sub-units or stocks for determining the potential for low frequency sound impacts on marine species.

This Section proceeds with an analysis of the potential impacts on mysticete whales, odontocetes, and the one pinniped endemic to the Hawaiian Archipelago.

4.3.1.1 Mysticetes

As discussed in Section 3, one mysticete, the humpback whale, is present in relatively large numbers in the Hawaiian Islands area (November/December to May). Although it is believed that fin, blue, and right whale territories in the North Pacific may overlap the region of the Hawaiian Archipelago, no blue whales have been sighted in the Hawaiian Islands. There has been only one confirmed right whale sighting, off Maui in 1979, and one fin whale sighting 37 km north of Kauai in 1994.

4.3.1.1.1 Potential Direct and Indirect Effects on Mysticetes

Direct and indirect effects of low frequency noise on mysticetes, including the potential for temporary threshold shifts, auditory interference by masking, behavioral disruption and habituation, long-term effects, and adverse impacts on the food chain (indirect effects), are discussed below.

Based on shore and aerial survey data for 1991-94 on humpback whales around Kauai and an average mysticete swim speed of 1-5.5 km/hr observed there (Frankel, pers. comm., 1995), it is believed that few individuals traveling through the study area would remain within the 120 dB source sound field (derived from FEPE acoustic model analysis) for more than 24 hrs at a time.

Broadband ambient noise levels in the 60-90 Hz band off the north shore of Kauai can be 76-98 dB (for sea state 2-6) (see Section 3.2.4.3) and are expected to be higher ($\geq$120 dB) when vessels are present. Based on information provided in Section 2, broadband levels from the proposed sound source at the water's surface are expected to be 135 dB at a radius of 1000 m (received level is not expected to exceed 136 dB at the water's surface anywhere in the vicinity of the source); 130 dB to a radius of 5 km; 120 dB at 12 km shoreward and 7.5 km seaward from the source; 110 dB to 55 km seaward. Underwater sound levels are expected to be: 140 dB at 288 m depth (562 m range around source); 145 dB at 534 m depth (316 m range around source); 150 dB at 672 m depth (178 m range around source); 165 dB at 820 m depth (30 m range around source); and 195 dB at 850 m depth (1 m range around source). See Figure 2.2.1-6.

• Hearing Capabilities and Sound Production of Mysticetes: There have been no direct audiograms done on mysticetes. It generally is believed that they are adapted for hearing at low frequencies (below 1 kHz) (Fleischer, 1976, 1978; Ketten, 1994), and likely hear best in the frequency range of their calls (Evans, 1973; Myrberg, 1978; Turl, 1980). Baleen whale vocalizations range from below 10 Hz, to 25 kHz, with principal energy below 1 kHz (Table 4.3.1.1.1-1). At least 10 of the 11 extant species of mysticetes produce some form of low frequency sound below 400 Hz (Thompson et al., 1979; Watkins and Wartzok, 1985; Clark, 1990). Most of the low frequency sounds of coastal species, including fin and blue whales which can sometimes be found in coastal waters, are usually in the 100-400 Hz band, while those of pelagic (deep ocean) species are usually in the 10-100 Hz band. Fin whale sounds generally consist of 20 Hz pulses (Watkins, 1981b) and blue whales have been recorded producing loud (188 dB), long (>35 sec) triplets of infrasonic (<20 Hz) moans (Cummings and Thompson, 1971; Edds, 1982).

Table 4.3.1.1.1-1 lists the characteristics of underwater sounds produced by baleen whales found off the coasts of the United States.

Three sounds are produced by humpback whales: "songs" produced in late fall, winter, and spring by single animals; sounds produced by groups of humpback whales (possibly associated with aggressive behavior among males) on the winter breeding grounds; and sounds produced on the summer feeding grounds. The frequencies of these songs range from 40 Hz or lower, up to 4 kHz, with components of up to 8 kHz (Thompson et al., 1979). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al., 1979). The songs appear to have an effective range of approximately 10 to 20 km. Sounds often associated with possible aggressive behavior by males (Tyack, 1983; Silber, 1986) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead, 1983). Sounds are produced less frequently on the summer feeding grounds and are at approximately 20-2000 Hz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB (Thompson et al., 1986).

Blue whale moans within the low frequency range of 12.5-200 Hz, with pulse duration up to 36 seconds, have been recorded off Chile (Cummings and Thompson, 1971a). A short, 390 Hz pulse also is produced during the moan. Overall source level was estimated to be as high as 188 dB, with most energy in the 1/3-octave bands centered at 20, 25, and 31.5 Hz, as well as secondary components near 50 and 63 Hz (Cummings and Thompson, 1971a). Each sound was uttered as a 3-part sequence.

Low frequency sounds (<110 Hz) have been recorded from at least six blue whales spread over 6 km^2 of the Gulf of Mexico (Thompson et al., 1987). Four of the animals, possibly subadults, were traveling in pairs, and almost half of the recorded sounds were stereotyped doublets, unlike the sounds recorded by Cummings and Thompson in the southern hemisphere, and others recorded off California and Oregon (Cummings, pers. comm., 1991).

U.S. Navy Sound Surveillance System (SOSUS) underwater hydrophones in the western North Atlantic tracked a solitary blue whale for 41 straight days during February-March 1993. The distinct downward sweep of the "commas" on the spectrograms identifying the animal were typically between 15-20 Hz and approximately 60 sec apart (Gagnon, pers. comm., 1993).

Species	Signal Type	Frequency Range (Hz)	Dominant Frequencies (Hz)	Source Level (dB re 1 µPa at 1 m)	References
Fin Whale	moans, downsweeps	14-118	20	160-186	Watkins 1981b; Watkins et al. 1987; Edds 1988
	constant call	20-40	-	-	Edds 1988
	moans, tones, upsweeps	30-750	-	155-165	Watkins 1981b; Cummings et al. 1986; Edds 1988
	rumble	10-30	-	-	Watkins 1981b; Edds 1988
	whistles?, chirps?	1500-5000	1500-2500	-	Thompson et al. 1979
	clicks?	16,000-28,000	-	-	Thompson et al. 1979
Blue Whale	moans	12-390	10-30, 50-60	188	Cummings and Thompson 1971a; Edds 1982
	clicks?	6,000-8,000	6,000-8,000	130, 159	Beamish and Mitchell 1971; Beamish 1979
		21,000-31,000	25,000		
Bryde's whale	moans	70-245	124-132	152-174	Cummings et al. 1986
	growl	400-800	-	-	Edds and Odell 1989
Minke whale	down sweeps	60-130	-	165	Schevill and Watkins 1972
	moans, grunts	60-140	60-140	151-175	Schevill and Watkins 1972; Winn and Perkins 1976
	ratchet	850-6,000	850	-	Winn and Perkins 1976
	clicks	3,300-20,000	<12,000	151	Beamish and Mitchell 1973; Winn and Perkins 1976
	thump trains	100-2,000	100-200	-	Winn and Perkins 1976
Sei whale	two phrases of 10-20 FM	1500-3500	3000	-	Cummings 1989
	sweeps each; 30-40 msec/				Thompson et al. 1979
	sweep				Knowlton et al. 1991
Gray whale	moans	20-1,200	20-200, 700-1,200	185	Cummings et al. 1968; Fish et al. 1974; Swartz and Cummings 1978
	pulse modulated	80-1,800	225-600	-	Dahlheim et al. 1984
	FM up-down sweep	100-350	300	-	Dahlheim et al. 1984
	pulses	100-2,000	300-825	-	Dahlheim et al. 1984
	clicks (calves only)	100-20,000	3,400-4,000	-	Fish et al. 1974; Norris et al. 1977
Humpback whale	song components	40-8,000	100-4,000	144-174	Thompson et al. 1979
	shrieks	-	750-1,800	179-181	Thompson et al. 1986
	horn blasts	-	410-420	181-185	Thompson et al. 1986
	moans	10-1,900	25-360	175	Thompson et al. 1986
	grunts	25-1,900+	-	190	Thompson et al. 1986
	pulse trains	25-1,250	25-80	179-181	Thompson et al. 1986
	underwater blows	100-2,000	-	158	Beamish 1979
	fluke & flipper slap	30-1,200	-	183-192	Thompson et al. 1986
	clicks	2,000-8,200	-	-	Winn et al. 1979b; Beamish 1979
Bowhead whale	tonal moans	25-900	100-400	129-178	Ljungblad et al. 1982a; Cummings and Holliday 1987; Clark et al. 1986
	pulsive	25-3,500	-	152-185	Würsig et al. 1985; Clark and Johnson 1984; Cummings and Holliday 1987
	song	20-500	<4,000	158-189	Cummings and Holiday 1987
Right whale (Southern)	tonal	30-1,250	160-500	-	Cummings et al. 1972; Clark 1983
	pulsive	30-2,200	50-500	172-187	Cummings et al. 1972; Clark 1983
				181-186	C. Clark (in Würsig et al. 1982)

? Infrequently recorded, and/or questionable correlation of sound with species.
(from Richardson et al., 1991)
Note: Not all found in Hawaiian waters.

Table 4.3.1.1.1-1 Characteristics of baleen whale sounds

• Potential for physical auditory effects: With respect to physical auditory effects, exposure of humans to high sound levels can accelerate the normal process of gradual hearing deterioration with increasing age (Kryter, 1985), resulting in a permanent threshold shift (PTS). This could presumably apply to marine mammals, as well. Ketten (1994) melds current knowledge about acoustic trauma with marine mammal ear data as a framework for an informed, albeit theoretical, discussion of what auditory impacts to marine mammals, if any, are likely. The following are excerpts from her findings (impact estimates are based on extrapolations from available data):

> Marine mammals are acoustically diverse with wide variations in ear anatomy, range, and sensitivity. Like land mammals, dolphins, whales, and seals have ears that are essentially a fluid-filled bony spiral containing a resonating membrane and a series of frequency-pressure-energy detectors. With this basic device, some animals (e.g., dolphins) hear well into the ultrasonic range (>20 kHz), while others (baleen whales) hear well into the infrasonic range (<50 Hz). Frequency ranges (hearing capacity) differ for each species based largely on differences in stiffness and mass of middle and inner structures. There are also important differences among species in their sensitivity in any frequency band.
>
> Marine mammals have both large hearing ranges and specialized ear structures adapted to the acoustic characteristics of water rather than air-borne sound. Their middle and inner ears are heavily modified from terrestrial mammal ears to accommodate rapidly changing pressures encountered in deep dives, and acoustic power relationships several magnitudes greater than in air. These adaptations may coincidentally lessen the risk of injury from high intensity noise to some extent.
>
> A key component of whether or not a hearing loss occurs is an animal's ability to hear the frequencies of that sound source. Virtually all studies show that the extent of a hearing loss depends on the frequency sensitivity of the animal, and that losses center around the peak spectra of the source. For pure tones and narrow band sound sources of short duration (<1 hr), threshold shifts occur at the frequency of the stimulus. Any hearing impairment that may occur at frequencies beyond those of the sound source would be expected to be much less pronounced, unless the stimulus continues for very long time periods (e.g., a hydroelectric power plant generator) or rapidly reaches an exceptionally high broadband intensity (e.g., a seismic air gun).
>
> Any damage is proportional to an animal's sensitivity. For most terrestrial species, a signal must have an intensity 80 dB over the hearing threshold of the animal, at that particular frequency, to produce a temporary threshold shift. Therefore, a moderately intense sound source near an animal's best frequency could possibly affect its hearing in that range, but would probably have little effect in other parts of its hearing range.

The duration of a threshold shift is generally correlated with both the length of time and the intensity of exposure. If the exposure is short (<1 hr), hearing is usually recoverable (i.e., temporary threshold shift (TTS) occurs); if great (>8 hr/day), hearing is more prone to permanent degradation (PTS). With short duration, narrow band stimuli, recovery periods can vary from hours to days. TTSs have been produced in humans with underwater sound sources at levels of 150-180 dB for frequencies between 700-5600 Hz (most sensitive range of human hearing). [Hollien (1993) makes the argument that the dynamic range of human hearing underwater may be lower than that described in Section 4.5.1.1 of this EIS, which is based on underwater threshold experiments of three investigators. There is no information as to whether the human range, or some lower range, applies to marine mammals. If a lower value is appropriate, then the received level that would cause a mysticete to incur TTS could be less than the assumed 150 dB.]

Given the similarities of whale and seal ears to land mammal ears, it is certainly possible that a relatively intense sound source, like the proposed acoustic thermometry signal, could produce acoustic impacts in some--but not all--species in that sound field. Because the acoustic thermometry signal has a narrow frequency band with slow onset, losses in any one animal are likely to be restricted to frequencies in or near the broadcast band. Assuming TTS and PTS in marine mammals occur at intensity-duration limits similar to those in land mammals, and therefore that such noise trauma requires a signal 80 dB over threshold, this means only those species capable of detecting signals lower than 90 Hz with sensitivity level below (better than) 115 dB threshold (+80 = 195 dB, maximum project source level at 1 m range from the source) could possibly be adversely impacted.

As an example, audiograms and anatomical data on marine mammal hearing ranges imply that the humpback whale is likely to have adequately sensitive low frequency hearing to be a candidate for temporary threshold shift from the project source. For the humpback, a 150 dB or greater signal could represent a significant hazard with repeat exposures. Any TTS would likely be limited to the lower limit of their hearing range. Given that transmission loss estimates stated elsewhere in this EIS are correct, intersecting a 150 dB level requires a dive depth >670 m, which is believed to be beyond the normal limit for humpbacks for even a single dive, let alone the many dives necessary to incur PTS due to sound levels >80 dB above assumed threshold level. It is unlikely that the hearing of any humpback whale would be adversely affected physiologically outside the 150 dB sound field.

Based on Ketten's analysis, it appears possible that mysticetes could experience discomfort or a temporary elevation of their hearing threshold if exposed to the source in the high intensity zone (i.e., ≥150 dB). A temporary elevation in threshold levels would most likely last from a few minutes to hours (TTS can be experienced for days in some cases, depending on the level and duration of noise exposure, among other factors). If TTS occurred, it could temporarily reduce an animal's ability to hear calls, echolocation sounds, and other ambient sounds. Based on Ketten's findings and assuming that the calculated sound field levels are correct, to suffer TTS, the animal must be:

- capable of hearing signals below 90 Hz and have hearing sensitivity below (better than) 70 dB (150 dB-80 dB=70 dB) for frequencies below 90 Hz (assuming that TTS would occur for received levels >80-100 dB above the absolute threshold, as for humans listening in air, and that sound field levels are correct).

- capable of diving deeper than 670 m (2200 ft) (making the same assumption as above).

- within the 150 dB isopleth (at 670 m depth, 178 m radius from the source); choose not to depart or be unable to depart the area; and/or be subjected to repeated exposures. In this regard, it is assumed that if an animal considered the sound to be annoying, it would depart the area during the 5-min source ramp-up period. All marine mammals have adequate swim speed to accomplish this.

Provided that the above assumptions/criteria are correct and, as research data indicate, that none of the four mysticete species are expected to dive to depths greater than 670 m, it appears highly unlikely that they would experience direct effects, such as TTS or PTS.

Another concern which has been raised with respect to physical auditory effects is that marine mammals exposed to the source could be injured or killed as a result of sound-induced physiological damage, similar to that experienced by two humpback whales that died apparently as a result of being exposed to two 5000 kg underwater explosive charges off the coast of Newfoundland. Ketten notes, however, that there is a great difference between simple acoustic trauma and blast injury, and that the humpback whales that died had experienced extensive ear damage as a result of an extreme, sharp onset pressure source (Ketten, Lien and Todd, 1993), unrelated to acoustic energy levels. In this respect, it is instructive to compare the acoustic energy level originating from a single underwater explosion to the acoustic energy level in a single ATOC source transmission. Using the aforementioned example of a 5000 kg charge of TNT as an example, and applying the basic formula by Urick (1967), elicits the following results:

Peak Explosive Overpressure, $p_o(\mu Pa) = 1.49X10^{14}(W^{1/3}/r)^{1.13}$
where,

W = Charge weight in lbs (note that 5000 kg = 11,000 lbs)
r = range in ft

and the related time constant, $t_o(sec) = 58X10^{-6}\ W^{1/3}(W^{1/3}/r)^{-0.22}$

The total acoustic energy, E, in this shock wave is given by:

$$E = p_o^2 t_o/(2\rho c)$$

where ρc is the characteristic impedance of sea water.

To illustrate, at a range of 100 yds (91.4 m) from a 5000 kg charge:

$p_o(\mu Pa) = 7.8x10^{12}$ µPa at 91.4 m
$t_o(sec) = 2.28x10^{-3}$ sec

Similarly, the relative acoustic energy from a 20 min acoustic thermometry source transmission at a range of 91.4 m can be calculated as follows (assuming a source level of 195 dB re 1 µPa-m, and spherical spreading losses to 91.4 m):

$p_o(\mu Pa) = 5.6x10^{7}$ µPa at 91.4 m
$t_o(sec) = 1.2x10^{3}$ sec

On a logarithmic basis, the ratio of the two source energies is given by:

$$10Log_{10}[E(20\ min/E(5000\ kg\ TNT)]_{@91.4\ m} = -45.7\ dB$$

Thus, at a nearby range of 91.4 m, the proposed project source would produce 45.7 dB (45,700 times) less acoustic energy over a full 20 min transmission than a single 5000 kg explosive charge. The ATOC source, of course, does not produce an explosive shock wave, the peak pressures from the two sources being different by a factor of more than 100,000 in magnitude.

Mitigation Measure 3-1: A Marine Mammal Research Program (MMRP) will be carried out in connection with the project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential physical auditory impacts on mysticetes, a goal of the MMRP will be to validate the assumptions regarding population distribution and diving behavior, which form the basis for predicting the potential for effects from the sound source.

- Potential for behavioral disruption: Previous studies of mysticete responses to human-made noise have examined short-term behavioral responses to broadband industrial and recreational vessel noise extending from below 75 Hz to 1000 Hz. There are no data on potential auditory effects of a sound with specific ATOC source characteristics. To estimate how the available data relate, or scale, to ATOC source transmission characteristics, the following must be accounted for: 1) ATOC source bandwidth is 35 Hz, whereas noise produced by industrial and recreational vessel sources usually have wider bandwidths (e.g., a semi-submersible drillrig's broadband signals can cover as much as 3200 Hz [80-4000 Hz] [Greene, 1986], and a 70 hp outboard motor's bandwidth is on the order of 3600 Hz [400-4000 Hz] [Stewart et al., 1982]); 2) maximum duty cycle for the ATOC source would be 8%, whereas available data from industrial sources usually is based on duty cycles >50%; 3) peak power output of the ATOC source would be 180 dB/Hz at 75 Hz; total power, integrated across the entire 35 Hz bandwidth (57.5-92.5 Hz) would be 195 dB. Although most available data are not directly relatable to projected ATOC source transmission parameters, basic physical acoustic phenomenology can be applied. In so doing, estimates of potential impacts based on analysis of available data can, for the most part, be considered relatively conservative.

Based on available studies and reported observations, the possible short-term reactions of mysticetes disturbed by human-made noise include interruption of feeding, resting, or social activities, abrupt diving, swimming away, and change in vocalization patterns (Finley, 1982; Calkins, 1983). There are few data available concerning the potential effects of various types of sound and other disturbance on cetacean vocalization patterns (e.g., call type, rate and intensity). Moreover, there is little information about the consequences if communication, echolocation, or ambient sounds are masked for various periods of time. Too little is known about the functions and importance of these natural sounds in the lives of even the best-studied species of marine mammals. Masking affects primarily the weaker sound signals received from distant sound sources, and the masking noise must be strong in order to conceal strong signals from close sources. There is little information about the importance to marine mammals of hearing the weak sounds that are most subject to masking (Richardson et al., 1991). During the 1991 Heard Island Feasibility Test (HIFT), sperm whales and pilot whales were heard in 23% of 1181 min of baseline acoustic surveys, but in none of the 1939 min during transmissions (57 Hz at 209-220 dB source level). Both species were heard within 48 min after the end of the test (Bowles et al., 1994). It is unknown whether the animals' hearing was masked during this time or that they only responded by curtailing their vocalizations.

There is also a great deal of variability in animal responses, even among individuals of the same species. Reasons for this variation can be physical (e.g., varying/increasing as opposed to steady sound levels; sound propagation conditions; and background noise levels) and/or biological (e.g., the animals' activity; age and sex class; habitat; habituation, and individual variation) (Richardson et al., 1991).

Studies of the effects of simulated and actual oil industry noise on bowhead whales *(Balaena mysticetus)* conducted in the Beaufort Sea from 1980 to 1991, showed a wide variation in behavioral reactions to received levels of noise depending, in part, on the source and characteristics of noise, the whales' activities when exposed, and the physical situation, as well as individual variation among animals exposed. Reactions to increasing noise levels from approaching boats occurred at received levels as low as 90 dB. In both spring and summer, approximately half of the whales exhibited avoidance when the received level of steady drillship or dredge noise was about 115 dB, or 20 dB above ambient. However, in the spring some whales tolerated the levels of drilling sound up to 135+ dB if the only available migration route through ice required close approach to a sound projector. Whales exhibited avoidance behavior to repetitive pulses from airgun arrays only at received levels exceeding 150-180 dB (as well as more subtle behavioral changes to weaker pulses) (Richardson et al., 1991).

Acoustic disturbance studies conducted by Malme et al. (1984) showed a 50% avoidance to continuous sound levels of >120 dB by all gray whales sighted during the test conducted with a source over the side of a vessel located in the middle of the gray whale migration path. The change in behavior of the migrating whales was brief and minor, involving a slight deflection in the migratory path. One could argue that the animals simply detected a potential obstruction and made a relatively mild deflection in their course to avoid the obstacle (NRC, 1994). For impulsive airgun sounds of <0.5 sec duration, effective pulse levels 30 to 50 dB higher are required to produce 50% avoidance for the same species. The 120 dB value appears to be roughly constant among the mysticetes tested, including gray whales (Malme et al., 1984; Tyack et al., 1991); bowhead whales (Richardson et al., 1991); and humpback whales (Malme et al., 1985), but is qualified by species, social context, and source characteristics. In general, observations indicate that marine mammals show fewer and less pronounced short-term behavioral responses to sources with constant and predictable acoustic characteristics, than to sources with variable and unpredictable acoustic characteristics (Malme et al., 1984; Richardson et al., 1985), but this has not been quantified.

Studies were conducted by Frankel, Herman, and Mobley in 1985-86 (reported by Mobley et al., 1988) of humpback whales in Hawaiian waters exposed to the playback of humpback songs (50 Hz-10 kHz), social sounds (200 Hz-3 kHz), Alaskan feeding calls (450-550 Hz), artificially synthesized sounds (10 Hz-1.4 kHz), and blank tape control. Results showed that the minimum received level that produced a strong reaction (rapid approach to the boat) was 113 dB for an empirical model using 17logR for transmission loss to estimate received levels based on source levels.

According to Maybaum (1989), humpback whales in Hawaiian waters exhibited avoidance behaviors (i.e., increased their distance from the sound source) when presented with sounds of a 3.3 kHz sonar pulse, a sonar frequency sweep from 3.1 to 3.6 kHz, or a control (blank) tape. While the two types of sonar signals differed in their effects on the whales, both elicited avoidance behaviors (the animals increased their distance from the sound source). The strength of this effect varied directly with time. Responses to the frequency sweep primarily consisted of increased swimming speeds and track linearity. The latter was a direct function of increasing sound intensity. Overall, the sounds did not strongly or consistently affect the whales' dive cycles or vocalizations. Observed avoidance reactions may have resulted from possible resemblance between the sonar signals and natural sounds in the humpback's environment that are associated with biological threats or warnings.

During gray whale migration, Wyrick (1954) noted that the animals changed course at a distance of 200-300 m to move around a vessel in their paths. Sumich (1983) recorded that the fastest moving grays near a boat breathed and used energy more rapidly than slower whales. Hubbs and Hubbs (1967) suggested that migrating gray whales disturbed by ship/boat traffic tend to exhale more underwater and expose their blowholes only to inhale. Cummings and Thompson (1971b) noticed the same behavior in response to playbacks of killer whale sounds (one of their only predators). Bursk (in Atkins and Swartz, 1989) reported that the rate of course change by migrating grays can be correlated with the number of vessels in the vicinity, particularly whale-watching boats. In the presence of boats or playbacks of outboard noise, gray whale call rate increased, call structure changed, and average received levels of calls increased. The higher received levels were interpreted to mean that source levels of the calls had also increased in the presence of boat noise, not because the whales were seriously disturbed, rather to reduce masking of the calls by the boat noise (Dahlheim et al., 1984).

Cowles et al. (1981) noted that the eastern Pacific gray whale population continues to migrate along the west coast of North America, despite the growing number of ships, boats, low-flying aircraft and thrillcraft.

In summary, variations in sensitivity to human-made noise between and within marine mammal species and lack of information about the consequences of short-term disruptions on marine mammals, make it difficult to define the criteria of their responsiveness and to assess the consequences of a disruption in their natural activities. Disruption of marine mammals as a result of human-made noise can be expected to result in interruption (at least briefly) of normal behavioral and social interactions with other animals of their species, an increase in energy cost (whether or not feeding was disrupted), and displacement to a habitat that may be less suitable. Displacement also can have the benefit of removing the animal from a location where, had the animal remained, there might be more serious consequences (e.g., by reducing the masking effect of the human-made noise or the physiological stress that might continue if the animal remained close to the noise source).

Social disruption is a potentially important disturbance factor. Animals that are aggregated may flee in different directions upon the approach of a fast, noisy vessel or thrillcraft, or low-flying aircraft. The duration of this social disruption rarely has been measured, but is sometimes several hours (e.g., cetaceans engaged in cooperative feeding or sexual activity) (Richardson et al., 1991). The possible consequences of this intrusion on marine mammals are poorly understood. It could possibly result in changes to social order, sexual behavior, parental care, or cooperative activities. It only can be assumed that repeated social disruption is a disadvantage because it could decrease or disrupt activities that would have occurred naturally and, in turn, could adversely affect the social ordering that probably took some measure of time and energy to establish.

The possibility of separation of dependent young from their mothers is a potentially severe consequence of disturbance-induced social disruption. Although, in baleen whales, older nursing calves occasionally are separated from their mothers by a few hundred meters, with apparently no ill effects detected.

Richardson et al. (1991) suggested that these isolated disturbance incidents usually have minimal or no lasting effects, as marine mammals around the globe continuously cope with occasional disruption of their activities by predators, poor weather conditions, unusual ice conditions at high latitudes, and other unpredictable natural phenomena.

Richardson et al. (1991) also speculated that although there is little definite information about the long-term effects of short-term disturbance reactions, isolated disturbance incidents usually have minimal or no lasting effects and that the energetic consequences of most single disturbance incidents probably are insignificant. They noted, however, that recurrent incidents of interrupted feeding and rapid swimming, if sufficiently frequent, can have negative effects on the well-being of individuals. The frequency and duration of disturbance that might initiate negative effects are unknown, and would undoubtedly depend on the species, area, feeding requirements, and reproductive status of the marine mammals involved (e.g., animals in regions with abundant and widely distributed food resources would likely be less severely affected than in areas where feeding is necessary but suitable food is less readily available). Animals most severely affected would likely be pregnant or lactating females and other animals subject to heavy natural energy drain.

Richardson et al. (1991) also noted that the long-term implications of prolonged disturbance, as might occur if a stationary and continuously noisy human activity were established near a marine mammal concentration area, would depend, in part, on the degree to which the marine mammals habituate. If they fail to habituate and, as a consequence, are excluded from an important concentration area or are subject to ongoing stress while in that area, then there could be long-term effects on the individuals and the population. Conversely, when habituation occurs, as it does for some marine mammals exposed to ongoing human activities, then the consequences may be minimal.

As summarized by Richardson, et al. (1991), some marine mammals have been found to tolerate, at least over periods of a few hours, continuous sound received at levels greater than 120 dB. During one study, 50% of migrating gray whales exhibited avoidance reactions at industrial noise levels (drill ship) of 117-123 dB, and 10% reacted to levels ≥110 dB. It is doubtful that many marine mammals would remain in areas where received levels of continuous noise remain at or above 140 dB, unless hearing is impaired. Tolerance of mysticetes to an ATOC source transmission sound level of 120 dB, at 2% or 8% duty cycles, is uncertain.

Some general conclusions can be drawn from the relative abundance of various mysticete species in relationship to the ATOC sound fields. The only mysticete expected in the area is the humpback whale, and because they usually prefer nearshore locations (inside the 100-fathom [200 m] depth contour), few are expected to be exposed to received levels > 120 dB. This theory is supported by the 1993-94 MMRP baseline data as shown in Figures 4.3.1.1.1-1, -2, and -3. Note that the total number of humpback whales located inside the predicted 120 dB sound field during the designated time periods were 4, 0, and 5, respectively. The full reports on these data collection activities are included in Appendix G.

> *Mitigation Measure 4-1: As provided in mitigation measure 2-1, the duty cycle and power levels of the ATOC source would be adjusted to the minimum necessary to support research objectives, so that potential impacts to mysticetes would be minimized.*

> *Mitigation Measure 4-2: As provided in mitigation measure 3-1, a MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential impacts on mysticetes, a goal of the MMRP will be to identify the nature, frequency, and significance of any responses to ATOC source transmissions.*

Source installation and operation at any of the site alternatives would also be expected to have minimal impacts from potential behavioral disruption on mysticetes, except for the autonomous moored source alternative, where the uncertainty of increased numbers of mysticetes other than humpback whales necessitates the assessment of this potential to be unknown.

• Potential for habituation: Habituation was defined by Richardson et al. (1991) as the development of reduced response when there is repeated or continuous exposure to a stimulus and when the stimulus is not accompanied by anything that the animal "perceives" as threatening. Many human-made sounds, both waterborne and airborne, fall into this category. While relatively few studies of habituation in marine mammals have been done, several cases of apparent habituation have been reported in baleen whales (Watkins, 1986; Dolphin, 1987; Malme et al., 1985; Richardson et al., 1985c, 1990b) which suggest they tend, over time, to become less sensitive to certain types of repeated noise and disturbance which they perceive as non-threatening. Animals are also more likely to habituate to a sound with relatively steady characteristics than to a highly variable sound.

Richardson et al. (1991) noted that it is not known how often an animal must be exposed to a stimulus to remain habituated (e.g., whether animals exposed and habituated to a disturbance during one year would still be habituated the next year).

Several cases of apparent habituation have been reported in baleen whales. When wintering gray whales first enter the calving lagoons of Baja, California, they are wary of small boats. However, later in the winter they are less cautious, and some individual animals actively seek out motorboats (Swartz and Jones, 1978). Watkins (1986) suggested that, near Cape Cod, reactions of various species of baleen whales changed over the years as whale-watching cruises became popular. Some species, particularly humpback and fin whales, have become less wary of boats in recent years. Dolphin (1987) reported that humpbacks off southeast Alaska initially reacted to an outboard motorboat used in his research, but soon accommodated it. Malme et al. (1985) suggested that reactions of humpbacks to noise pulses from an airgun waned after the first exposure. Richardson et al. (1985, 1990b) found that some bowheads remained near dredges and drillships that were producing continuous noise, even though bowheads exhibited at least weak avoidance reactions at the onset of about the same levels of drillship or dredge noise. These observations suggest that marine mammals, like other animals, tend, over time, to become less sensitive to noise and disturbance to which they are repeatedly exposed. However, this reduction in responsiveness is not likely to occur if the animals are harmed or harassed severely when exposed to the noise or disturbance.

Generally, habituation effects can be considered beneficial, since they limit the direct impact of a stimulus. Habituation can be detrimental, however, if it leads to a lack of response to hazardous situations or, in the case of noise, results in hearing loss. For example, habituation to low frequency sounds, including sounds from large vessels, could lead to decreased avoidance of vessels and increased injury or death from collisions. It can also limit an animal's capability to hear vocalizations from other animals. However, in the ATOC source vicinity, noise from existing vessel traffic would be expected to have a much greater habituating effect than that from

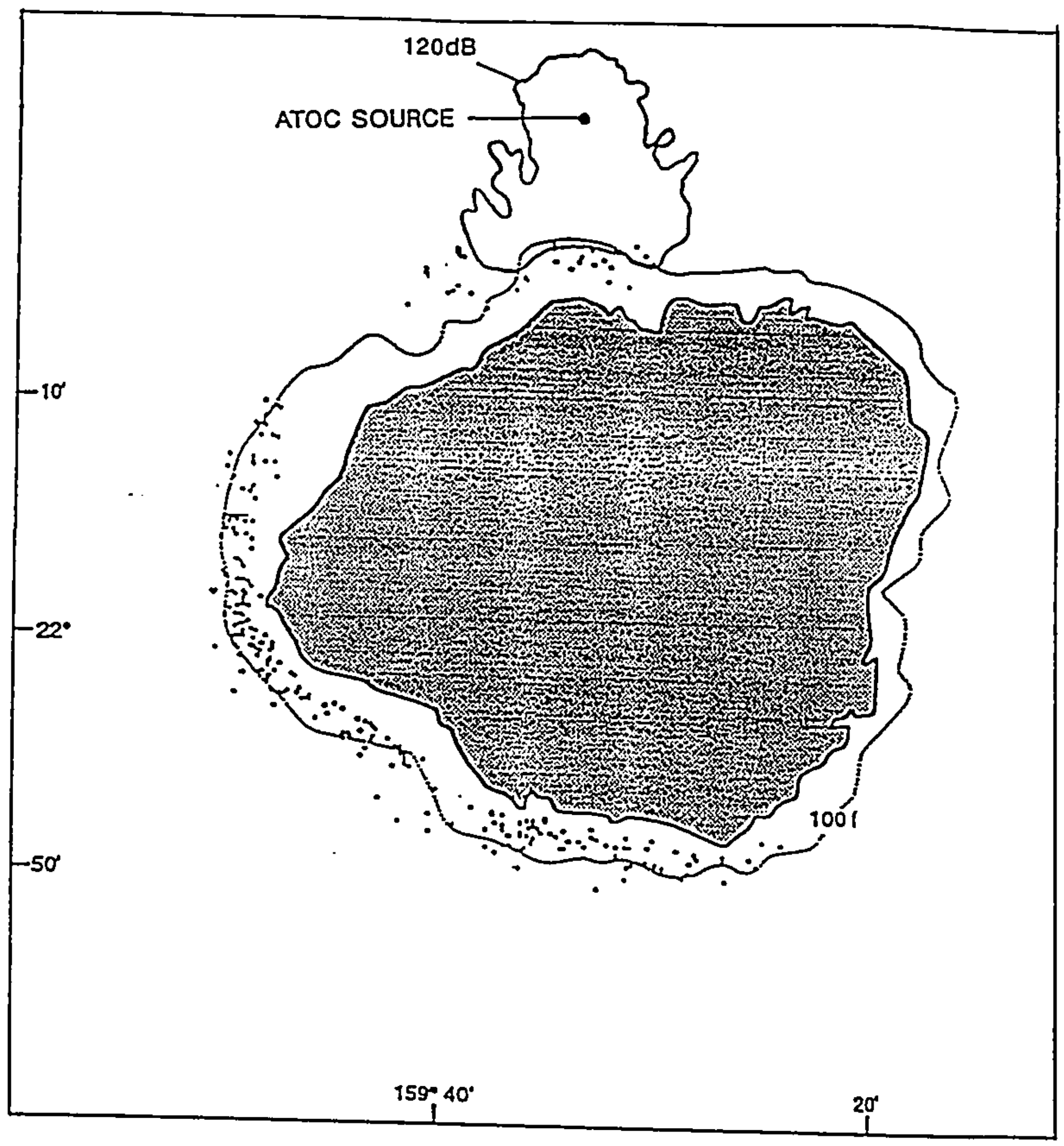


Figure 4.3.1.1.1-1 Kauai source sound field (120 dB at 100m depth superimposed on 1993 MMRP photo-ID locations of humpback whales (1/30/93-4/21/93)

RECEIVED AS FOLLOWS

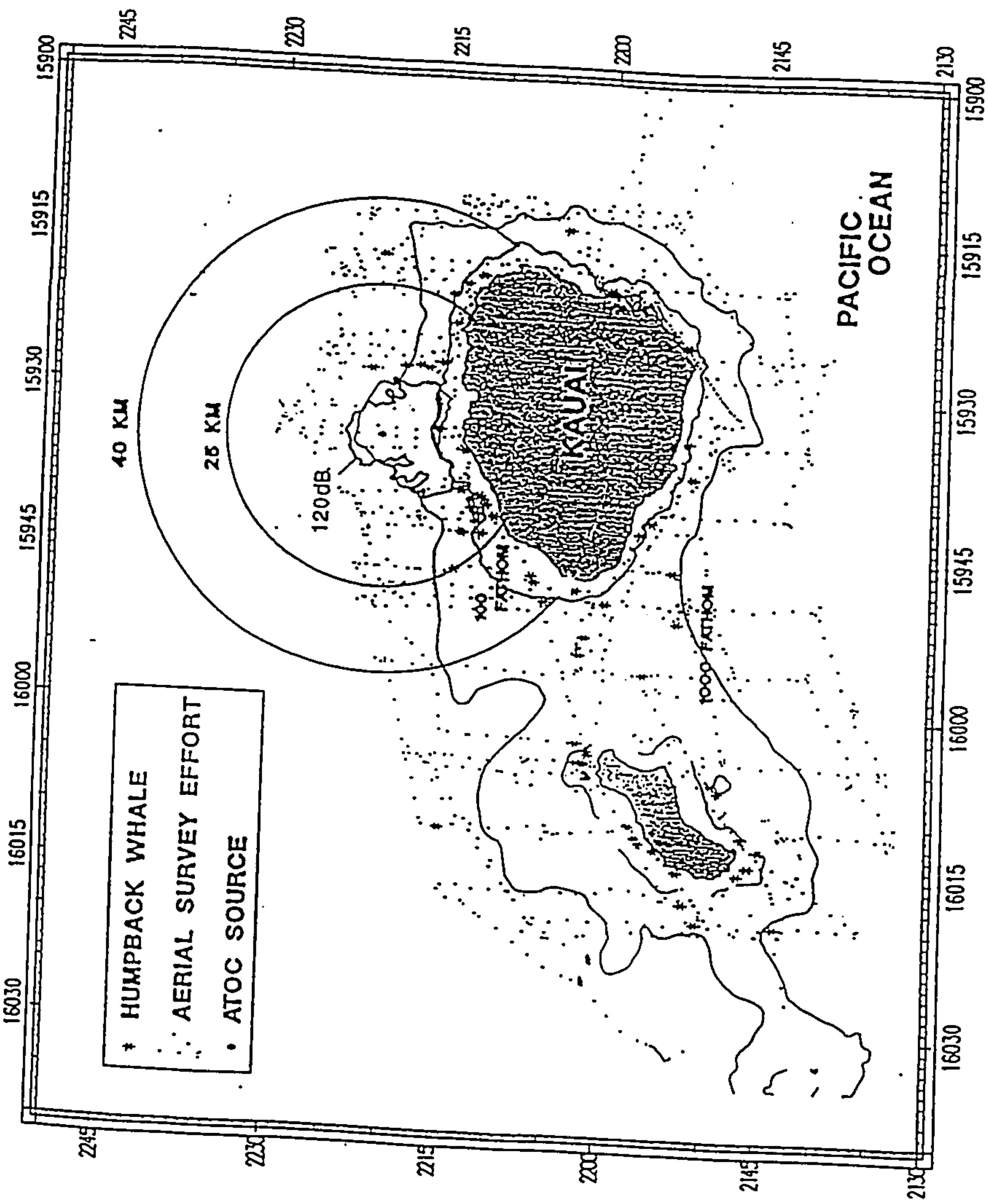
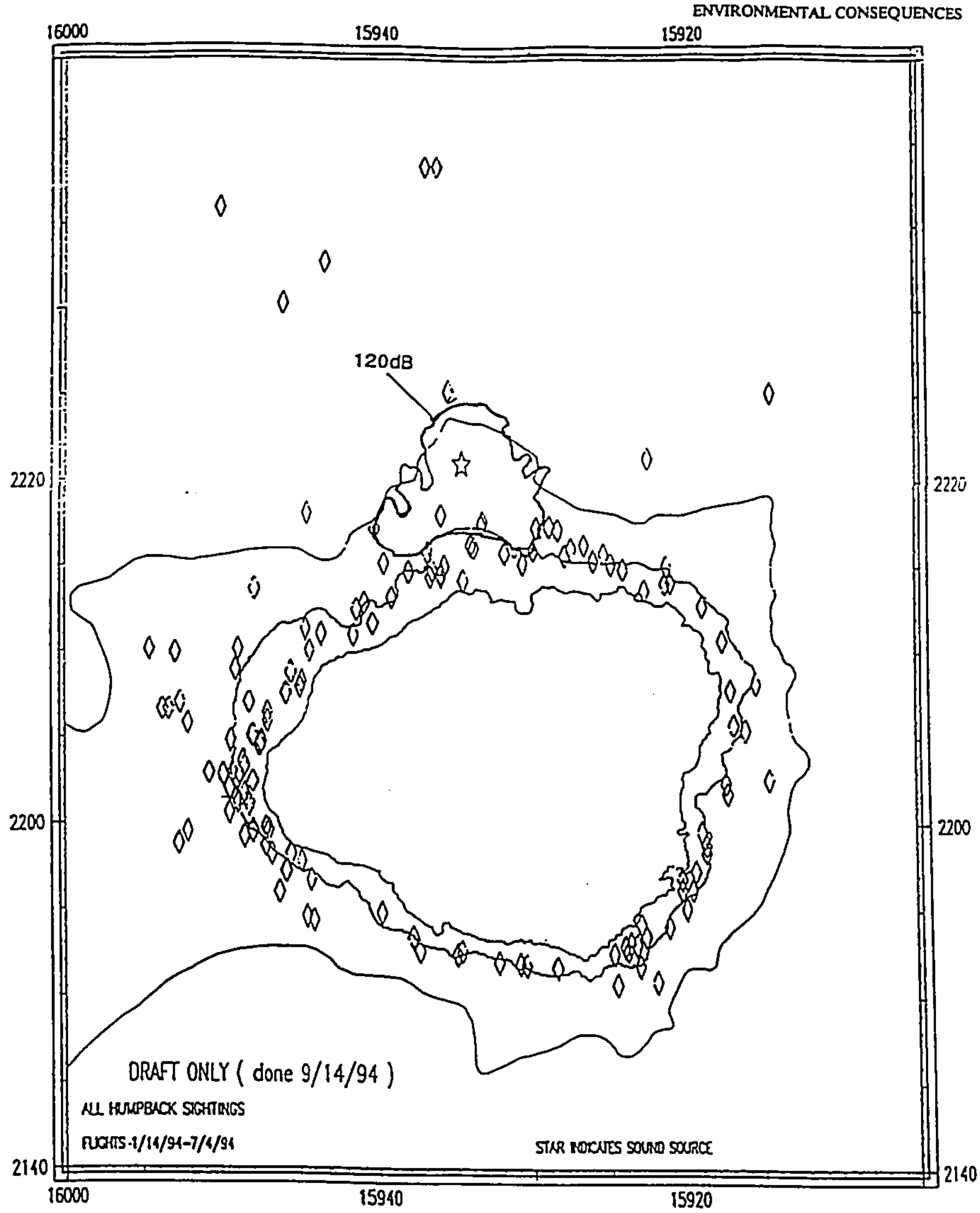


Figure 4.3.1.1-2 Kauai source sound field (120 dB at 100m depth) superimposed on 1993 MMRP aerial survey locations of humpback whales (2/1/93-3/26/93)



(from Mobley et al., 1994)

Figure 4.3.1.1.1-3 Kauai source field (120 dB at 100m depth) superimposed on 1994 MMRP aerial survey of humpback whales (1/14/94- 7/4/94) the ATOC sound source, yet no such increase in collisions from habituation has been documented.

• Potential for long-term effects: According to Richardson et al. (1991), it is rarely possible to identify the specific cause of an apparent long-term effect (e.g., prolonged displacement), and even the occurrence of displacement can be difficult to detect. However, that there are a few reports of probable or possible long-term displacements of marine mammals from local areas in which underwater noise was presumably a major factor. The best documented of these reports was the abandonment by gray whales of a calving lagoon in Baja California for several years, and their return after vessel traffic diminished (Gard, 1974; Reeves, 1977; Bryant et al., 1984). Apparent distributional changes of humpback whales around Maui, as a result of human activity, are discussed in Subsection 4.3.1.1.2 below.

Changes in marine mammal use of an area may be quite slow and difficult to detect, given the long lifetimes of most marine mammals and the slow rate of change in habitat quality in many areas. Most of the research directed specifically at this topic has been done in the past 15 yrs. If marine mammals did react to noise from human activities by reduced use of certain areas, there would, in many cases, be insufficient reliable and systematic information to document the trend. In contrast, it is rather straightforward to document cases where marine mammals remain in an ensonified area. Thus, cases of partial or even complete abandonment of disturbed areas may be more common than available evidence indicates (Richardson et al., 1991).

Surveys were done in 1984 to determine the effects of noise on gray whales that calve and breed in San Ignacio Lagoon, Mexico (Jones et al., 1994). Regression analysis of the high gray whale counts in the years 1978-82 and 1985 indicated that, during that seven year period, the maximum number of whales present in the lagoon increased an average of 4.5%/yr. The study results suggested that the noise-effect studies conducted in 1984 caused both single whales and cow-calf pairs to abandon or avoid the lagoon, but most, if not all, of the whales returned and used the lagoon in 1985, as they had during the 1978-82 timeframe. The 1984 noise-effect studies consisted of continuous long-term underwater playbacks of the following sounds: killer whale, oil-drilling rig, outboard motor, gray whale vocalizations, and a calibration test tone. Source levels ranged from 70 dB (200 Hz) up to 145 dB (2.5 kHz), and the ambient noise levels measured in the lagoon were quite high, at 94-110 dB (mostly in the 2-5 kHz frequency band).

Although the potential significance of permanent displacement is difficult to determine, Richardson et al. (1991) speculated that in an area of small size relative to range, where the density of animals is low, and similar to the densities in many other areas, it is unlikely to be critical either to individuals or to the population. They noted, however, that effects of displacement would be more problematical in areas consistently used by high concentrations of animals or areas important to a small, but critical component or function of the population (e.g., mothers with calves, or mating).

Animals that appear to tolerate human-made noise are presumed to be less affected by the noise (e.g., through habituation) than are others whose behavior is changed overtly, sometimes with displacement. However, as noted by Richardson et al. (1991), the presence of marine mammals in an ensonified area does not prove that the population or individuals therein are unaffected by the noise (i.e., the number of animals in the ensonified area may be only a fraction of the numbers that would have been there in the absence of the noise). Also, as noted earlier, marine mammals may stay in an area despite the presence of a noise disturbance if there are no alternative areas that meet their requirements (Brodie, 1981b). In response to such situations, animals may experience stress, causing physiological responses. Although such responses may increase an animal's ability to cope with various situations (Turner, 1965; Russell, 1966; Selye, 1973), chronic activation of these physiological mechanisms eventually could lead to harmful physiological effects (Selye, 1973).

According to Richardson et al. (1991) only one study of noise-induced stress in marine mammals has been conducted. Thomas et al. (1990) measured plasma catecholamines (elevated levels often found in stressed mammals) in captive white (beluga) whales before and after exposure to playbacks of recorded semi-submersible drillrig noise. Although noise exposure did not lead to elevated levels of catecholamines in the animals' blood, Richardson et al. (1991) note that the significance of the study results is unknown, especially in view of the short durations of noise exposure. The long-term health effects of chronic noise exposure are unknown, although it appears that marine mammals do exhibit some of the same stress symptoms as terrestrial mammals (Thomson and Geraci, 1986; St. Aubin and Geraci, 1988). Studies of terrestrial mammals have shown that physiological reactions, such as elevated heart rate, may occur even in the absence of overt behavioral responses (MacArthur et al., 1979).

In summary, the potential for adverse impacts from long-term exposures to the ATOC sound fields is unknown; however, all marine mammal exposures to subsea sounds would be minimized wherever feasible.

Mitigation Measure 5-1: As provided in mitigation measure 2-1, the duty cycle and power levels of the ATOC source would be adjusted to the minimum necessary to support research objectives, so that potential long-term impacts to mysticetes would be minimized.

Mitigation Measure 5-2: As provided in mitigation measure 3-1, a MMRP would be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C to this EIS. With regard to potential long-term impacts on mysticetes, a goal of the MMRP will be to identify the nature, frequency and significance of any long-term changes due to ATOC source transmissions (via comparison of animal distribution data before, during, and after source transmission periods over a two-year period).

Source installation and operation at any of the site alternatives would also be expected to have minimal potential long-term impacts on mysticetes, except for the autonomous moored source alternative, where the uncertainty of increased numbers of mysticetes other than humpback whales necessitates the assessment of this potential to be unknown.

• Potential for masking: Masking processes in baleen whales are not amenable to laboratory study, and no data on hearing sensitivity are available for these species. Yet, as noted previously, mysticetes and other marine mammals likely are well-adapted to coping with some increase in masking as a result of natural and human-made noise. However, since baleen whales are assumed to be sensitive to low frequency sound, the maximum radius of audibility of low frequency industrial noise for these species is to be determined by background noise levels. As noted earlier, it is not currently possible to determine with any level of quantitative precision the potential consequences of elevated background noise levels, particularly when they are temporary and local. More data are needed on: 1) the functional importance to marine mammals of faint signals from other members of their species, predators, prey, and other natural sources; 2) the 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 their call intensities and perhaps frequencies to minimize masking effects.

Masking as a result of human-made noise can interfere with the detection of acoustic signals, such as communication calls, and other environmental sounds that may be important to marine mammals and, at least in theory, a source of noise will be surrounded by a region within which masking may occur. However, the size of this zone is highly variable, even for a single marine mammal and a single type of noise. The maximum radius of masking depends on several factors. Among the most important of these is the received level of the noise relative the original signal.

For an animal close to a source of human-made noise, the noise level would be high and the animal would be able to hear only nearby animals. For an animal farther from an industrial site, the noise level would be lower and the animal would be able to hear calls from more distant animals. The same arguments apply to detection of other environmental sounds that may be of interest to the animals.

Dramatic reductions in maximum potential radius of communication could result if ambient noise levels are increased by 10-20 dB throughout that range, while other factors (e.g., the animals' directional hearing ability, and the directionality of the noise source[s]) remain relatively constant. Species that may communicate acoustically over long distances, such as some baleen whales, would be most seriously affected. There is little information about the functions of most marine mammal calls. Hence, it is impossible to predict the effects of a reduction in the range to which these calls are detectable. Payne and Webb (1971) suggested that some baleen whales use powerful low frequency calls to communicate over very long distances. However, there is no evidence that whales respond to one another over ranges greater than about 20-25 km (Watkins, 1981b), but this may be largely a result of limited observation methods (Richardson, pers. comm., 1994).

During the proposed sound transmissions (mostly 2% of the time), sound levels (in the 57.5-92.5 Hz band) in the vicinity of the source, and out to a radius of approximately 500 km, could be greater than average ambient levels. At these times, masking of communication calls and other environmental sounds which may be important to mysticetes could occur in some portion of the ensonified area if those sounds are in the same band as the ATOC source.

However, there is virtually no information about the nature and effects of masking under field conditions, nor about the adaptations that marine mammals may use to reduce masking effects. The few relevant data on masking have come largely from studies of high frequency echolocation by toothed whales. The importance to mysticetes of barely-detectable calls from distant conspecifics is unknown, so the biological significance of masking of faint calls is, likewise, unknown, and may be minor or negligible at most times (Richardson, pers. comm., 1994). Thus, the extent to which masking may occur, or the extent to which mysticetes might be affected by such masking is unknown.

For species with broad spectrum hearing, presumed to be the case for mysticetes, masking from a narrowband source, such as ATOC, may be incomplete. Moreover, the relatively short transmission times and low duty cycle mean that the source only would mask sounds for brief periods; sounds longer than this would not be completely masked (e.g., a ship approaching from a distance). Therefore, in light of the number of mysticetes that may be exposed and the relatively brief and intermittent nature of the ATOC source transmissions, masking effects are uncertain, but presumed to be minor for all alternatives.

• Potential for indirect effects: Indirect effects include those effects that potentially could be caused by the proposed action and are later in time, or farther removed in distance, but would still be reasonably foreseeable. The principal indirect effect in this case would be any potential impact on the food chain that ultimately could affect mysticetes in the vicinity of the study area. Althougn rare, isolated incidents of serendipitous feeding by humpback whales in Hawaiian waters have been observed by researchers (Diaz-Soltero, pers. comm., 1995). Humpbacks primarily feed on euphausiid prey species (*Thysanoessa spinifera*) during winter months in central California waters (Schoenherr, 1991; Kieckhefer, 1992).

Humpbacks are known to feed almost continuously during summer months in North Pacific (high latitude) and Arctic waters on one species in particular, the red euphausiid shrimp *(Euphausia pacifica)*, commonly called krill, but also on schools of mackerel, sand lance, capelin, and herring (Jurasz and Jurasz, 1979). This provides a major food source for humpbacks and other mysticetes in the region (e.g., blue, fin, sei). The euphausiids provide these animals an unusually efficient two-step food chain, enabling a much greater biomass of large animals to be supported than would be the case if most of them preyed upon animals of intermediate size (McConnaughey, 1970).

If low frequency sounds were to affect krill, or benthic fauna, depending on the extent to which their availability might be altered, there could be negative consequences to the marine mammals that feed on them. There is laboratory evidence that such sounds can affect egg viability and growth rates of fish and invertebrates (Banner and Hyatt, 1973; Lagardere, 1982). Thus, intense sounds in the open ocean (e.g., ≥150 dB), potentially could affect the availability of organisms in the food chain of marine mammals, even if these organisms do not have auditory receptors.

MMRP activities, and acoustic source transmissions under the proposed action that would be conducted from the seabed off the north coast of Kauai, or the Johnston Atoll alternative, would have no effect on the primary food species of humpbacks in the North Pacific and Arctic regions and, consequently, probably no effect on their food chain. The potential for the moored source alternative to affect food species for any of the mysticetes that may inhabit the vicinity of the moored source would be directly dependent on the site(s) selected. Presumably, a principal criterion for moored autonomous source site determination would be a low density of mysticetes which would, in turn, minimize the potential for indirect effects.

For a more thorough discussion of the potential direct, indirect, and cumulative impacts of the proposed action on krill and other invertebrates, which are the prey species of mysticetes, see Section 4.3.2.3. The potential direct and indirect effects of the alternatives are summarized in Table 4.3.1.1.3-1.

4.3.1.1.2 Potential Cumulative Effects on Mysticetes

The types of actions that might reasonably be considered to have the potential to interact to affect mysticetes in the study area are noisy activities: e.g., merchant shipping and other vessel-related activities, recreational water activities, marine and nearshore construction and resort operations, aircraft operations, and research activities that could add cumulative noise stimuli to the marine environment. The discussions below also account for MMRP-related activities: 1) aerial visual surveys/observations, 2) shipboard acoustic surveys/observations.

- Merchant shipping and other vessel-related activities: In addition to the potential for vessel collisions, noise from ships and boats is a cause for concern in relationship to impacts on baleen whales.

Collisions with ships are an increasing threat to many whale species. As ships get larger and faster and the numbers of vessels and/or whales increase, the incidence of encounters is expected to increase. Commercial and recreational vessels are potential collision threats to whales in offshore regions of the north Kauai coast.

According to Glockner-Ferrari et al. (1987), the number of physical injuries to calves, juveniles, and adult humpbacks as a result of collisions with boats has increased in Hawaiian waters. At least 5 humpbacks photographed in southeastern Alaskan waters have exhibited large dents or gashes on the upper body that probably were caused by collisions with vessels. Most of those whales were also noticeably skittish when approached by boats or skiffs for fluke photography (NMFS, 1991).

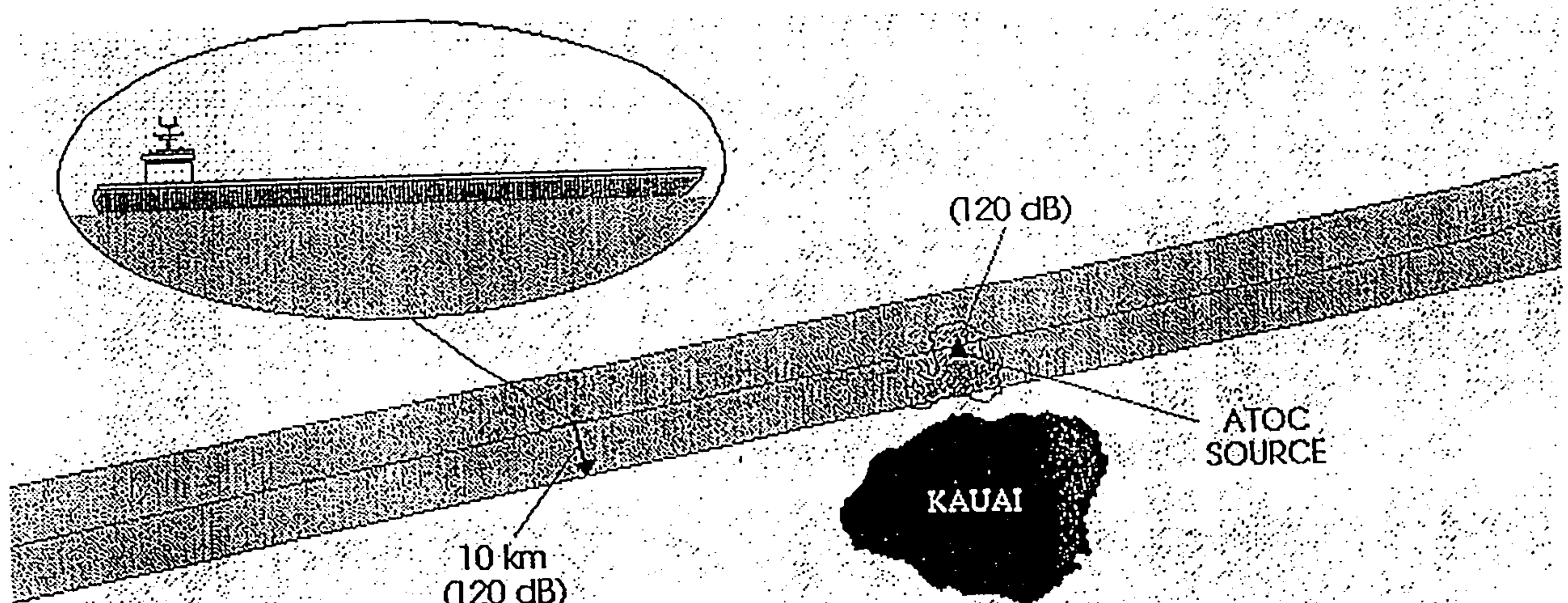
Vessel size, hull construction, speed, mode of operation, and state of maintenance, among other things, influence ship noise levels. Large vessels generally produce more sound than small vessels; fully loaded (or towing/pushing) ships produce more sound than partially full or empty ships; speed increases noise in both loaded and unloaded vessels; and older or more poorly maintained vessels generate more noise than newer or well-maintained vessels. Source levels in the strongest third-octave band may range from 150-160 dB for outboards and other small vessels, to 185-205 dB for supertankers and large container ships (Richardson et al., 1991). Supertankers or other large ships may create potentially disturbing noise for many kilometers around the vessel (Tyack, 1989) (Figure 4.3.1.1.2-1 superimposes an idealized supertanker's area of influence over that of the proposed Kauai site's). The most significant source of noise in many waters, cavitation (bubbles) produced by ship propellers, may be impossible to eliminate. Physical oceanographic factors (Payne and Webb, 1971; Watkins and Goebel, 1984) and submarine topography influence sound propagation and, therefore, the distance at which sound might affect a whale's behavior (NMFS, 1991).

Short-term disturbance of humpback whales by vessels has been investigated in Alaska (Baker et al., 1982, 1983; Kreiger and Wing, 1984; Baker et al., 1988) and in Hawaii (Bauer and Herman, 1986). Observed responses to vessels included attempts to move away, changes in patterns of breathing and diving and occasional displays of possibly aggressive behavior. Baker et al. (1983) described the responses of whales to vessels as follows: 1) "horizontal avoidance" of vessels 2-4 km away, characterized by faster swimming with few long dives; and 2) "vertical avoidance" of vessels from 0-2 km away, during which whales swam more slowly, but spent more time submerged. Other responses observed, such as trumpeting (Watkins, 1967a) or breaching (Whitehead, 1985), lobtailing, or flipper slapping may sometimes indicate disturbance, but may also signify general excitability (Baker et al., 1988). The significance of the extra energy costs incurred by whales responding in these ways is not known. Whales appear to respond less to vessels when actively feeding (Baker et al., 1988) or energetically involved in any other behavior (Hall, 1982).

Responses of Hawaiian humpback whales to vessel traffic were monitored over two winter seasons during 1983-1984 off Maui, Hawaii. A variety of vessel characteristics including vessel numbers, speed, and proximity were associated with changes in whale behaviors, including swimming speed, respiration, and social behaviors. Smaller pods and pods with a calf were more affected than larger pods. A case study suggested that a calf could be so sensitized by the passby of a large vessel, that it subsequently breached in response to noise from a smaller boat engine which previously elicited no behavioral change. The overall results (although differing with categories of whales; e.g., singers, single adults, mothers, calves) suggested that humpbacks often avoid (e.g., by increased frequencies of surfacing without blows and dives initiated without raised flukes) or, in some cases, exhibit direct threat behaviors toward vessels at distances of 0.5-1 km away. These findings, in conjunction with similar results from summering humpbacks in Alaskan waters, indicated disturbance of humpback whales at both winter and summer ranges. The researchers concluded that although substantial short-term effects were noted, the potential long-term negative consequences of such short-term stress (e.g., on fertility) could not be assessed (Bauer, 1986; Bauer and Herman, 1986). It should also be noted that humpback whales may not respond to noise or other stressors until some threshold level is exceeded.

Richardson et al. (1991) summarizes that marine mammals show wide within-species variations in sensitivity to human-made noise. They sometimes continue their normal activities in the presence of high levels of human-made noise, while at other times members of the same species exhibit strong avoidance at much lower noise levels. This apparent variability is partly attributable to variations in physical factors, specifically the characteristics of the human-made noise, its attenuation rate, and the background noise level. However, the variability in responses

KAUAI SOURCE SOUND FIELD
VERSUS SUPERTANKER SOUND FIELD



120 DECIBEL AREA EQUIVALENTS	
ATOC SOURCE	SUPERTANKER (100,000 tons; 20 knots)
244 km^2	17,760 km^2 / DAY

Figure 4.3.1.1.2-1 Kauai source sound field vs. supertanker sound field

is also partly attributable to real differences in the sensitivity of different animals, or of the same animal at different times. Some of these differences are associated with differences in activities (e.g., resting vs. feeding vs. socializing), age and sex differences, habitat effects, habituation, and residual individual variation. Thus, the radius of responsiveness varies widely among individuals, between locations, and over time. No single criterion of disturbance will apply to all circumstances, even for a particular type of animal and a particular human activity.

Northern right whales have shown lack of responsiveness to boat noise in the Cape Cod area during mating or surface feeding (Mayo and Marx, 1990). Watkins (1986) found that northern right whales generally moved slowly, but consistently away from passing ships, often dived quickly when disturbed, and were consistently quiet when disturbed. Right whales seen from whale-watching vessels tend to orient away from the vessels when first spotted, but not when last seen (Kraus, in Atkins and Swartz, 1989).

There have been virtually no detailed, calibrated behavioral studies on the reactions of fin, blue and minke whales to vessel noise. However, reactions of these three species to vessel traffic while they were summering in the St. Lawrence estuary have been described in three studies (1973-75, 1979, 1980). During the first two-year period, 232 vessel-whale encounters were opportunistically observed (Mitchell and Ghanime, 1982). In about 15% of the cases, the animal(s) departed the vicinity of the boat/ship noise immediately. About 85% of the time, they remained in the area, but most changed direction abruptly or dove to avoid close approach by the vessel. When whales remained (probably within range of the vessel sound field), surfacing and respiration patterns did not change in any consistent way.

Based on the second study, Edds and Macfarlane (1987) found that fin whales avoided most vessels by slight changes in heading, or by increasing the duration and speed of underwater travel. Edds and Macfarlane also believed that low frequency vessel noise masked some fin social sounds, and higher frequency outboard motor noise masked minke whale sounds. However, they did continue to vocalize in the presence of vessel noise (Edds, 1988).

The behavior of fin and blue whales was observed in the third study, during 1980. Macfarlane (1981) noted that the manner of approach, rather than the boat size or distance, seemed critical--a slow approach, even by a large boat, usually caused little reaction; but fast, erratic approaches to blue whales reportedly caused flight reactions, separation of a pair, shorter series of respirations, and temporary movement out of the area.

• Recreational water activities: Increased vessel traffic and a significant increase in human activities off the coast of almost all the main Hawaiian Islands since the 1940's and 50's appears to have resulted in decreased numbers of humpbacks in those areas. Herman (1979) noted that humpback density "tends to be inversely related to the concentration of human population on shore or human-related offshore marine activities." Similarly, Kaufman and Wood (1981) stated that "usage of the observation area [varied] inversely with the amount of daily boat traffic."

Glockner-Ferrari and Ferrari (1985) reported that parasailing operations (involving towing a person in a parachute harness behind a high-speed motorboat) in combination with jet skis, inter-island hydrofoils, and other boat traffic in the Lahaina-Kaanapali area, have resulted in humpbacks abandoning preferred nearshore resting areas. Green and Green (1990) also reported a reduction in whale sightings in their study area as a result of parasail operations.

Based on the above information, albeit limited in detail and geographical scope, it would appear that there may be some correlation between increased recreational water activities in the Hawaiian Islands and lower numbers of mysticetes in proximity to those activities.

• Marine and nearshore construction and nearshore resort operations: According to Shallenberger (1978), noise, vibration, and turbidity associated with construction (e.g., pile driving, blasting, dredging, filling, etc.) at or near shoreside may cause whales to abandon an area. Bowhead whales tolerate some dredging noise, but are displaced when dredge noise is sufficiently strong (Richardson et al., 1990).

Cetaceans, all of which remain in the water throughout their lifetime, are presumably less susceptible to nearshore disturbances caused by increased human presence (e.g., during construction or nearshore resort operations) than are pinnipeds that haul out on land. However, gray whales summering close to shore near St. Lawrence Island, Alaska, have been reported to move away when humans appear or move about on the shoreline (Sauer, 1963).

Major facilities, such as hotels and condominiums, located nearshore often generate noise from air conditioning equipment, swimming pool pumping systems, inc. into the ocean environment. Townsend (1991) used the Kaanapali, Maui area as an example in this regard, noting that it has over six major resort hotels and at least six condominium complexes containing shoreside swimming pools, networks of fountains and waterfalls, and large ventilation and air conditioning systems, and contributes to large numbers of swimmers in the nearshore zone.

The potential for impacts on mysticete habitat due to nearshore resort operations would most likely be related to small boat (thrillcraft, parasailing, fishing, whale-watching), and small aircraft (whale-watching, etc.) operations that occur in proximity to the animal(s). The possible effects of these resort activities on the whales' environment have not been directly assessed to date. However, as stated above, it has been reported that parasailing operations, in combination with jet skis, inter-island hydrofoils, and other boat traffic in the Lahaina-Kaanapali area, have resulted in humpbacks abandoning preferred nearshore resting areas. There has been some increase in humpback numbers since the recent ban on thrillcraft in the area (Ferrari, pers. comm., 1994).

• Aircraft operations: Aircraft are known to affect whales. Shallenberger (1978), Herman et al. (1980), and others found, however, that whales did not react consistently to aircraft. Aircraft flying as high as 305 m (1000 ft) can elicit responses from whales, while aircraft at half that height sometimes do not. Factors that are known or suspected to affect reactions to aircraft include the loudness of the engines, lateral distance from the aircraft to the animal, speed of the aircraft, wind speed, wave height, water depth, distance from shore, and the age, sex, number, and activities of the whales.

In Hawaiian waters, inter-island commuter traffic and small private planes are the major sources of potential aerial disturbance. These planes fly regularly among all the islands, often crossing areas of high whale concentrations at altitudes of 305 m and less. Pilots occasionally divert from their flight path to circle whales so that passengers can view or photograph them. Helicopter tour operators also disturb humpback whales by flying low or hovering in their vicinity (Tinney, 1988). Noise from low-flying aircraft has apparently declined in the past few years, in response to greater awareness and recognition of the potential for disturbing whales.

Noise from military airplanes and other government exercises also are potential sources of disturbance. In Hawaii, aerial exercises are executed with planes from Hickam Air Force Base, Kaneohe Marine Corps Air Station, and Barbers Point Naval Air Station on Oahu. concerns about the possible effect of military activities on humpback whales were addressed in a consultation between the U.S. Navy and NMFS regarding the use of Kahoolawe as a target island in 1979. Subsequently, the Navy has ceased using the island as a target range. It has been suggested that humpback whales arriving in Hawaiian waters may be disturbed by military aircraft flying over portions of the Auau Channel between the Big Island and Maui. Herman et al. (1980) suggested that humpback whales arriving in Hawaiian waters may be disturbed by military aircraft flying low over portions of the Auau Channel between the islands of Hawaii and Maui.

In general, whale reactions to aircraft overflights vary depending on their activities and situations. Whales engaged in feeding or social behavior generally exhibit little reaction to aircraft that are not directly overhead or casting a shadow over them, whereas mother/calf pairs or whales in confined or shallow waters sometimes appear to be comparatively responsive. There is no indication that single or occasional aircraft overflights cause long-term displacement of whales.

• Research activities: There are currently eight Scientific Research Permits (SRPs) authorizing studies of humpback whales in Hawaii. Approved SRPs and pending SRP applications have been reviewed and considered non-duplicative with each other, or with the proposed action. There is relatively little geographic overlap in study areas. Scientists are required to coordinate research activities through NMFS's Southwest Region. Boats used strictly for scientific research include outboard motor-powered inflatable boats or runabouts less than 6 m long, sailboats up to approximately 12 m long, and inboard motor-powered boats up to approximately 15 m long.

Multiple noise sources in an area can increase natural ambient levels in the 50-100 Hz frequency band (normally 76-98 dB at sea state 2-6 [wave heights 0.3-2.4 m] based on analysis of a 1994 MMRP data set off the north shore of Kauai. Broadband ambient noise levels near ships (within approximately 0.25 km) can increase to 150 dB. The proposed source would contribute 103 dB (on an Leq basis over a 4-day period) to normal background broadband noise at ranges to approximately 12 km from the source (2% duty cycle). During actual transmission times, the contribution to the ambient noise field would be delineated by the sound fields discussed in Section 2. The simultaneous presence of these multiple noise sources in the area could potentially cause more frequent masking, behavioral disruption, and short- or long-term displacement. However, the effects of multiple noise sources on marine mammals have not been studied specifically, nor have there been any systematic studies of the effects of human-related activities on marine animals in north Kauai coastal waters.

Richardson et al. (1991) noted that the long-term consequences of multiple noise sources are likely to depend, in part, on the degree to which the animals habituate to repeated noise exposure. Based on the meager information that is available, they note that animals habituate more rapidly and completely if: 1) the various noise sources emit similar sounds, rather than sounds with varying acoustic characteristics; and 2) if the sources are stationary (e.g., offshore drillrigs), rather than moving (e.g., ships, boats, thrillcraft), provided that noise levels from the moving vessels are at least as intense as those from the drillrigs.

The presence of multiple noise sources in the study area would have the potential to increase the severity of any deleterious effects that might exist for a single source. For example, if animals are displaced from an area around some or all of these sources, the total amount of habitat affected would be greater than for any one source. Thus, a higher proportion of the population would likely be affected as the number of sources increases. If either animals or the noise sources are moving, an individual animal is likely to encounter a noise source more often as the number of sources increases. Thus, interruption of behavior, and possibly displacement, would be more frequent as the number of sources increases. The consequences of these presumptive situations remain uncertain, but would presumably be negative in nature.

Appendix C describes in detail the proposed aerial and vessel activities that would be associated with MMRP research efforts.

In summary, the project's incremental contribution to any cumulative impacts from other sources of subsea sounds or developments that affect the marine environment in the vicinity of the proposed project are speculative. Although continued increases in vessel traffic can be predicted, other effects (such as a shift to quieter vessels, changes in traffic patterns such as those that might result from redirecting Alaskan oil shipments from California to Asia via Hawaii. etc.) could mitigate or eliminate these increases. Additional knowledge gained from the MMRP, particularly if impacts deserving of governmental control are discovered, could result in measures to reduce subsea noise impacts through a shift in vessel traffic patterns, vessel noise standards, or similar measures. No additional mitigation measures beyond those already identified are proposed to address cumulative impacts.

• Future activities: There are no known future development activities in the north Kauai region that could reasonably be expected to interate or cumulate with the proposed action. The Barking Sands facility may be updated in the future, but that would be a wholly unrelated activity on the western side of the island, with no interconnectivity or cumulation with the proposed project. Any potential future activities on other Hawaiian Islands are speculative at this time, and would not be foreseen to interect or combine with the proposed project in a cumulative manner.

4.3.1.1.3 Summary and Conclusions Concerning the Effects on Mysticetes

This subsection summarizes the information presented in the previous subsections regarding potential effects of proposed operations and MMRP on mysticetes.

Humpback whales are found mostly in water depths <200 m, and have been known to dive as deep as 150 m. Average feeding depth appears to be 41-60 m. Humpbacks, like other baleen whales, are thought to have good low frequency hearing. They produce sounds from 40 Hz to 8 kHz, primarily centering around 100-300 Hz. The applicant estimates that a maximum of approximately 1700 humpback whales could enter the Hawaiian Island chain during the wintering season. A very conservative estimate of 25-50% of these (i.e., 425-850 individuals) could potentially pass through the study area at least once. Based on photo-ID work during the period 30 January to 21 April 1993 (Cerchio, 1994), 13.5% of the animals were resighted and mean resighting interval was 14.9 days (range was 1-50 days). However, it is believed that few whales would remain within the 120 dB source sound field for more than a day at a time, although some may remain in the Kauai area for longer periods. Therefore, it is possible that some source transmissions could partially mask humpback vocalizations during the 2-8% of the time the signal was being transmitted. However, due to their shallow diving depths, and propensity for water depths <200 m (based on 1993-94 aerial survey data), it is unlikely that humpbacks would experience PTS or TTS from the transmissions, provided assumptions are correct. The potential for humpback behavioral disruption is uncertain, but presumed to be low to moderate. Potential avoidance of areas inside the 115-120 dB sound field by a significant proportion of the humpback whale population off the Kauai north shore is possible, but the potential for this phenomenon must be addressed in light of the low source duty cycle (on 2-8% of the time; off 98-92% of the time) and the expected low numbers of animals to be in the 120 dB sound field (0-5 based on 1993-94 MMRP data).

Blue whales do not make prolonged deep dives, and are thought capable of diving to 200 m. They are probably sensitive to low frequency sound, and produce infrasonic moans in the 20-60 Hz range. Given their patterns of short, relatively shallow dives, their presumed low population density in the vicinity of the Hawaiian Islands, and lack of recorded observations, no acute or short-term effects (Table C-1) are expected.

Right whales are so rare that none would be expected to be exposed to project source transmissions. Only one has been sighted in the Hawaiian Islands, in 1979. Further, right whales are believed to be shallow divers (less than 200 m), and so would not experience high levels of exposure. Therefore, the potential for any impacts to right whales is remote.

Only one fin whale sighting has been recorded in the Hawaiian Islands (Mobley and Grotefendt, 1994b). They may dive to 335 m (Gambell, 1985) and are thought to hear in low frequencies, producing moans at 20 Hz. Conclusions for fin whales are similar to those for blue whales, above.

The potential for some masking in relation to any of the mysticetes cited must be stated as uncertain (but presumed low) due to the lack of available data.

Generally, due to the relative distribution and abundance of species at the alternative sites, the Johnston Atoll alternative would have less impacts (due to the expected lower abundance of animals), as would the moored autonomous source. The no project alternative would essentially have no impacts.

The potential impacts of playback experiments are anticipated to be similar to, but generally less than, those that would result from operation of the fixed, bottom-mounted ATOC sound source. The intensity of the mobile source sound transmissions would be less at the location of the source (by a factor of 100 to 1000) as compared to the fixed source. However, the mobile sound source would be located near the surface where most marine mammals reside, so that received sound levels experienced by individual animals could be greater than exposures would be to the fixed source at a greater depth. However, given the localized nature of these sound intensities, the limited number of transmissions that would occur, and the lower intensity, the potential impacts of the playback experiments would be expected to be minor.

Table 4.3.1.1.3-1 summarizes the potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS)	Assumptions: • Only mysticete that could potentially be affected is humpback whale. • Mysticete hearing sensitivity believed good at low freq. • Assume TTS occurs at received level (RL) ≥80 dB above hearing threshold; animal must enter 150 dB sound field to incur TTS. • Humpback whale (as well as blue, fin, right whales) are not known to dive deep enough to enter 150-195 dB sound field (>672 m depth) where TTS might occur. [Hollien (1993) states there is no info whether the human dynamic range of hearing, or some lower range, applies to marine mammals--if lower value is appropriate, then the RL that may cause TTS could be <150 dB.] • Maximum received level in surface waters where humpbacks could be located (<150 m depth, directly over source) would be 138 dB. • 130 dB sound field would be <5 km radius; 120 dB sound field <12 km radius.	Assumptions: • No physical auditory effects on mysticetes.	Assumptions: • Mysticete hearing sensitivity good at low frequencies. Humpback hearing sensitivity below (better than) 70 dB for frequencies <90 Hz. • Assume TTS occurs at received levels ≥80 dB above hearing threshold. • Assume sound field characteristics and duty cycles comparable to Kauai alternative, then assumptions 3-6 for Alternative 1 are valid for this site. • Fewer mysticetes (particularly humpbacks) expected at Johnston Atoll.	Assumptions: • Mysticete hearing sensitivity good at low frequencies. Humpback hearing sensitivity below (better than) 70 dB for frequencies <90 Hz. • Assume TTS occurs at received levels ≥80 dB above hearing threshold. • Cannot assume sound field characteristics for this site would be comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably a lower density of mysticetes could be expected in selected deep-water area. However, differences in sound fields for this site (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer mysticetes.
	None, provided assumptions are correct.	*None*	*None, provided assumptions are correct.*	*Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
DIRECT and INDIRECT EFFECTS				
Behavioral disruption and Habituation	Assumptions: • Sound fields and duty cycles as described above. • Good low frequency hearing capability for humpback whales and other mysticetes. • Residence time within ensonified area for any individual whale expected to be maximum of 4 days; few expected to remain more than 1 day. • Wide variations in sensitivity to human-made noise between and within mysticete species, due to physical and/or biological factors. • Animals may tolerate noise levels <130 dB at 2%-8% duty cycle. Potential for habituation if animals perceive noise as non-threatening. • Avoidance by a statistically significant proportion of humpbacks of areas inside the 115-120 dB sound field is possible, based on previous mysticete studies; but this possibility must be weighed against low source duty cycle (2-8%). • Animals more likely to habituate to a predictable noise source. *Uncertain, but presumed low to moderate, provided assumptions are correct.*	Assumptions: • No potential behavioral disruption or habituation. *None*	Assumptions: • Same as proposed action. • Probably lower density of mysticetes, particularly humpbacks. *Uncertain, but presumed low, provided assumptions are correct.*	Assumptions: • Sound fields and duty cycles as described above. • Good low frequency hearing capability for humpback whales and other mysticetes. • Residence time within ensonified area for any individual mysticete cannot be estimated. • Wide variations in sensitivity to human-made noise between and within mysticete species, due to physical and/or biological factors. • Animals may tolerate noise levels <130 dB at 2%-8% duty cycle. Potential for habituation if animals perceive noise as non-threatening. • Animals more likely to habituate to a predictable noise source. *Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual whales are unknown. • Residence time in area as described above. • Potential for stress from sound exposure uncertain at 2%-8% duty cycles. • Source sounds would be comparable to existing noise exposures. *Uncertain*	Assumptions: • No long-term effects due to MMRP or ATOC source transmissions. • No research would be done to assess long term displacement caused by other low frequency sources. *None*	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual whales are unknown. • Residence time in area as described above. • Assume sound field characteristics and duty cycles comparable to Kauai alternative. • Potential for stress from sound exposure uncertain at 2%-8% duty cycles. • Probably fewer mysticetes, particularly humpbacks at this site. *Uncertain*	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual whales are unknown. • Residence time in area as described above. • Cannot assume sound field characteristics for this site would be comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably a lower density of mysticetes in selected area. However, differences in sound fields for this site (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer mysticetes. *Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
DIRECT and INDIRECT EFFECTS				
Masking	Assumptions: • Mysticetes adapted for low frequency hearing. Source level of humpback whale calls 144-174 dB, up to 192 dB; effective range 10-20 km; other mysticetes' vocalizations also in low frequency range. • Sound fields: - 120 dB 12 km shoreward, 7.5 km seaward from source. - 130 dB 5 km around source. - 135 dB 1000 m around source. - 140 dB at 288 m depth (562 m range around source). - 145 dB at 534 m depth (316 m range around source) - 150 dB at 672 m depth (178 m range around source. - 165 dB at 820 m depth (30 m range around source) - 195 dB at 850 m depth (1 m range around source). • Duty cycles 2%-8% (maximum). *Uncertain, but presumed low, provided assumptions are correct.*	Assumptions: • No increase in masking for mysticetes. *None*	Assumptions: • Mysticetes adapted for low frequency hearing. Source level of humpback whale calls 144-174 dB, up to 192 dB; effective range 10-20 km; other mysticetes' vocalizations also in low frequency range. • Assume sound field characteristics and duty cycles comparable to Kauai alternative, then assumptions 2-3 for Alternative 1 are valid for this site. • Probably fewer mysticetes, particularly humpbacks, at this site. *Uncertain, but presumed none to low, provided assumptions are correct.*	Assumptions: • Mysticetes adapted for low frequency hearing. Source level of humpback whale calls 144-174 dB, up to 192 dB; effective range 10-20 km; other mysticetes' vocalizations also in low frequency range. • Cannot assume sound field characteristics for this site would be comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably a lower density of mysticetes could be expected in selected area. However, differences in sound fields for this site (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer mysticetes. *Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect mysticetes. • No mysticetes have been observed feeding in Hawaiian waters. • Mysticetes' primary feeding grounds are in North Pacific and Arctic waters where krill is plentiful during summer. • No impact of sound transmissions on primary mysticete food source in North Pacific and Arctic waters.	Assumptions: • No indirect effects.	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect mysticetes. • No mysticetes have been observed feeding in Johnston Atoll waters. • Mysticetes' primary feeding grounds are in North Pacific and Arctic waters where krill is plentiful during summer. • No impact of sound transmissions on primary mysticete food source in North Pacific and Arctic waters.	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect mysticetes. • Mysticetes' primary feeding grounds are in North Pacific and Arctic waters where krill is plentiful during summer. • Unknown whether source site(s) would be in vicinity of mysticete feeding grounds. • Potential impact of sound transmissions on primary mysticete food source unknown. • Source site selection would probably be based on low mysticete density.
	None, provided assumptions are correct.	*None*	*None, provided assumptions are correct.*	*Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Sources)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. • Recreational water activities. • Marine and nearshore construction and resort operations. • Aircraft operations • Research activities	Assumptions: • If sound transmissions continue throughout humpback breeding season, assuming normal movement patterns of whales through Hawaiian Islands, a proportion of wintering population could potentially move through ensonified area. • Higher proportion of population likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of noise sources increases; simultaneous presence of a number of noise sources expected to increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. Habituation likely to be more rapid and complete if noise sources emit similar sounds rather than varying characteristics. • Humpback whales appear to show some tolerance to noise-induced human activities in Hawaiian waters. *Uncertain*	Assumptions: • No cumulative effects due to MMRP or ATOC source transmissions. • All other noise-related activities would continue to contribute to cumulative effects on mysticetes. • Cumulative increases in impacts are speculative due to lack of known future cumulative sources. *None*	Assumptions: • Normal movement patterns of whales around Johnston Atoll unstudied; if sound transmissions would continue through humpback breeding season, proportion of wintering population that could move through ensonified area unknown. • Higher proportion of population likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of a number of noise sources expected to increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if noise sources emit similar sounds rather than varying characteristics. • Humpback whales appear to show some tolerance to noise-induced human activities in Hawaiian waters. *Uncertain*	Assumptions: • Normal movement patterns of whales around potential moored autonomous source sites unknown; if transmissions would continue throughout humpback breeding-feeding season, proportion of population that could move through ensonified area unknown. • Higher proportion of population likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of a number of noise sources expected to increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend, in part, on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if sources emit similar sounds rather than varying characteristics. • Humpback whales appear to show some tolerance to noise-induced human activities in Hawaiian waters. *Unknown*

Note: Humpback whale predominant mysticete in area and considered indicator species for research purposes; blue, fin, and right whale distribution patterns may overlap the Hawaiian Island region.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.1.3-1. Potential direct and indirect, and cumulative effects on mysticetes.

4.3.1.2 Odontocetes

As with mysticetes, the proposed sound transmissions may have the potential to adversely affect odontocetes, directly and/or indirectly. They also may have the potential to contribute to cumulative effects, including disturbance as a result of associated aerial surveys or observations. A description of the species of odontocetes expected to be found in the proposed study area is located in Section 3, and is not repeated here.

4.3.1.2.1 Potential Direct and Indirect Effects on Odontocetes

Section 3 discusses the species of odontocetes that have been sighted in or near the proposed study area during ship and/or aerial surveys. The maximum residence time within the area of the proposed action alternative for any individual odontocete is estimated to be <24 hrs (based on odontocete population estimates from NOAA NMFS, and ship and aircraft survey data through 1993-94, and known migration patterns, and swim speeds). However, based on average swim speeds of 9-30 km/hr (Webb, 1975; Lockyer, 1981a; Au and Perryman, 1982), it is believed that few, if any, individuals would remain within the 120 dB sound field area for more than 3 hrs at a time.

As noted previously, transmissions from the proposed sound source are expected to be 135 dB at a radius of 1000 m (received level is not expected to exceed 136 dB at the water's surface anywhere in the vicinity of the source); 130 dB to a radius of 5 km; 120 dB to 12 km shoreward and 7.5 km seaward from the source; and 110 dB to 55 km seaward from the source. Below the surface, sound levels are expected to be: 140 dB at 288 m depth (562 m range around source); 145 dB at 534 m depth (316 m range around source); 150 dB at 672 m depth (178 m range around source); 165 dB at 820 m depth (30 m range around source); and 195 dB at 850 m depth (1 m range around source).

Direct and indirect effects of low frequency noise on odontocetes include the potential for auditory interference by masking, behavioral disruption and habituation, long-term effects, and adverse impacts on the food chain (indirect effect), as discussed below.

• Hearing capabilities and sound production of odontocetes: Toothed whales, whose hearing has been studied, are most sensitive to sounds above about 10 kHz. This sensitivity of many toothed whales to high frequency sounds is related to their use of very high frequency sound pulses for echolocation and moderately high frequency calls for communication. There are three general categories of odontocete sounds (Watkins and Schevill, 1977a; Watkins et al., 1985a, b):

- Tonal whistles,
- Pulsed sounds of very short duration used in echolocation,
- Less distinct pulsed sounds such as cries, grunts and barks.

Sperm whales produce clicks rather than whistles, which may be used for echolocation (Mullins et al., 1988). Generally it is believed that most odontocetes also use whistle vocalization as "signature calls" to convey information about the specific identity of the sender. Sperm whales, it is believed, use clicks rather than whistles for this purpose and unique stereotyped click sequence "codas" have been recorded from individual whales over periods lasting several hours (Watkins and Schevill, 1977b; Adler-Fenchel, 1980; Watkins et al., 1985b). According to Weilgart and Whitehead (1988), sperm whale clicks also may convey information about the age, sex, and reproductive status of the sender.

Sperm whale clicks range from <100 Hz to 30 kHz, with most energy at 2-4 kHz and 10-16 kHz. Clicks are repeated at rates of 1-90 per second (Backus and Schevill, 1966; Watkins and Schevill, 1977b; Watkins et al., 1985a). Source levels of clicks for sperm whales at sea can be near 180 dB (Watkins, 1980a).

Table 4.3.1.2.1-1 lists the characteristics of underwater sounds produced by odontocetes. It should be noted that none of the dominant frequencies of odontocete vocalizations overlap with the ATOC sound source.

According to Richardson et al. (1991), odontocetes' upper limits of sensitive hearing range from at least 31 kHz in killer whales and near 70 kHz in false killer whales, to well above 100 kHz in some species. Low frequency hearing has not been studied in many species, but the bottlenose dolphin and white whale (beluga) can hear sounds at frequencies as low as 40-125 Hz. However, below about 10 kHz, sensitivity decreases with frequency. Below 1 kHz, sensitivity appears to be poor.

An underwater hearing experiment (Turl, 1993) suggested that an Atlantic bottlenose dolphin *(Tursiops truncatus)* may detect low frequency sound by some mechanism other than conventional hearing. The skin of the dolphin (and presumably other odontocetes) is highly innervated (Palmer and Weddell, 1964; Yablokov et al., 1974) and sensitive to vibrations (Ridgway, 1986) or small pressure changes in the area surrounding the eye, blowhole, and head region (Kolchin and Bel'kovich, 1973; Bryden and Molyneux, 1986). These authors suggest that dolphin skin receptors may detect changes in hydrodynamic and hydrostatic pressure, or perceive low frequency vibrations. It is possible that mechanoreception in cetaceans (Pryor, 1990) is yet another sense that performs its own specific role and, together with audition and echolocation, enables the animal to react to its environment.

• Potential for physical auditory effects: As discussed earlier in subsection 4.3.1.1.1, based on currently available data on acoustic trauma and the structure/mechanics of the marine mammal ear, Ketten (1994) speculated that if the calculated sound field levels are correct, to suffer TTS, the animal must be:

- capable of hearing signals below 90 Hz and have hearing sensitivity below (better than) 70 dB (150 dB-80 dB=70 dB) for frequencies below 90 Hz (assuming that TTS would occur for received levels >80-100 dB above the absolute threshold, as for humans listening in air);

Species	Signal type	Frequency Range (kHz)	Dominant Frequencies (kHz)	Source Level (dB re 1 µPa at 1 m)	References
Physeteridae					
Sperm whale	clicks	0.1-30	2-4, 10-16	160-180	Backus and Schevill 1966; Levenson 1974; Watkins 1980a
Pygmy sperm whale	echolocation	<2	-	-	Caldwell et al. 1966a; Caldwell and Caldwell 1987
	clicks	60-200	120	-	Santoro et al. 1989
Monodontidae					
White whale	whistles	0.26-20	2-5.9	-	Sjare and Smith 1986a,b
	pulsed tones	0.4-12	1-8	-	Sjare and Smith 1986a,b
	noisy vocalizations	0.5-16	4.2-8.3	-	Sjare and Smith 1986a,b
	echolocation	40-120	variable	160-222	Au et al. 1985, 1987
Ziphiidae					
Northern bottle-nose whale	whistles	3-16	-	-	Winn et al. 1970a
	clicks	0.5-26+	-	-	Winn et al. 1970a
Blainville's beaked whale	chirps/short whistles	<1-6	-	-	Caldwell and Caldwell 1971a
Mesoplodon sp.	clicks	to 80+	0.875	-	Buerki et al. 1989; Lynn and Reiss 1989
Delphinidae					
Killer whale	whistles	1.5-18	6-12	-	Steiner et al. 1979; Ford and Fisher 1983;
	pulsed tones	0.5-25	1-6	160	Awbrey et al. 1982; Ford and Fisher 1983; Schevill and Watkins 1966
	echolocation	0.1-35	12-25	180	Diercks et al. 1971, Wood and Evans 1980
False killer whale	echolocation	-	20-65	-	Thomas et al. 1988
	whistles	-	4-9.5	-	Busnel and Dziedzic 1968
Pygmy killer whale	echolocation?	-	-	-	Pryor et al. 1965
	growls, blats	-	-	-	Pryor et al. 1965
Long-finned pilot whale	whistles	1-8	1-5[1]	-	Steiner 1981; Taruski 1979; Busnel and Dziedzic 1966a
	echolocation	1-18	-	-	Busnel and Dziedzic 1966a
Short-finned pilot whale	whistles	0.5-20+	2-14	180	Fish and Turl 1976; Caldwell and Caldwell 1969
	echolocation	0.1-100	-	180	Evans 1973

1 Maximum and minimum frequencies.

? Questionable data

(from Richardson et al., 1991)

Note: Not all found in Hawaiian waters.

Continued

Table 4.3.1.2.1-1 Characteristics of underwater sounds produced by odontocetes

Species	Signal type	Frequency Range (kHz)	Dominant Frequencies (kHz)	Source Level (dB re 1 µPa at 1 m)	References
Bottlenose dolphin	echolocation	10-200	110-130	220	Au et al. 1974; Au and Penner 1981; Au et al. 1982
	whistles	4-18	9-12	-	Lilly and Miller 1961
	rasp, grate, mew, bark, yelp	-	-	-	Wood 1953
Northern right-whale dolphin	clicks	1-40+	40+?	180	Fish and Turl 1976
	whistles	?-16+	-	-	Leatherwood and Walker 1979
	tones	1-4	1.8, 3	-	Leatherwood and Walker 1979
Common dolphin	whistles	-	2-18	-	Caldwell and Caldwell 1968
	chirps	-	8-14	-	Caldwell and Caldwell 1968
	barks	-	<0.5-3	-	Caldwell and Caldwell 1968
	echolocation	0.1-150	20-100	180	Evans 1973; Fish and Turl 1976
Risso's dolphin	whistles	-	3.5-4.5	-	Caldwell et al. 1969
	clicks	<1-8	-	-	Watkins 1967b
	rasp/pulse burst	0.1-8+?	2-5	-	Watkins 1967b
Atlantic spotted dolphin	whistles	-	6-13	-	Caldwell et al. 1973a; Steiner 1981
	clicks	1-8	-	-	Caldwell and Caldwell 1971b
	squealy-squawk	0.1-3	-	-	Caldwell and Caldwell 1971b
	squawk	<1	-	-	Caldwell and Caldwell 1971b
	barks	0.1-3	-	-	Caldwell and Caldwell 1971b
	growls	-	-	-	Caldwell et al. 1973a
	chirps	4-8	-	-	Caldwell et al. 1973a
Striped dolphin	whistles	-	8-12.5	-	Busnel et al. 1968
Spinner dolphin	clicks	-	-	85-95?	Watkins and Schevill 1974
	whistles (= squeals?)	1-20	9-14[1]	109-125?	Watkins and Schevill 1972; Steiner 1981
	pulse bursts	-	2-3	108-115	Watkins and Schevill 1972
Atlantic white-sided dolphin	whistles	-	8-12	-	Steiner 1981
Pacific white-sided dolphin	whistles	2-20+	4-12	-	Caldwell and Caldwell 1970b, 1971c
	echolocation	0.2-150	60-80	170	Evans 1973
Rough-toothed dolphin	clicks	16-100+	-	-	Norris and Evans 1967
	whistles	-	4-7	-	Busnel and Dziedzic 1966b
Phocoenidae					
Dall's porpoise	clicks	0.04-12, 125-135	-	120-148	Evans 1973; Evans and Awbrey 1984
Harbor porpoise	clicks	100-160	130	132-149	Dubrovskii et al. 1971; Mohl and Andersen 1973
	clicks	2	-	100	Busnel and Dziedzic 1966a; Schevill et al. 1969

1 Maximum and minimum frequencies.
? Questionable data.

Table 4.3.1.2.1-1 Continued

- capable of diving deeper than 670 m (2200 ft) (making the same assumptions as above). The odontocetes in the area that are believed to be capable of diving below 670 m are the sperm whale and some beaked whales;

- within the 150 dB isopleth (a radius of 178 m from the source at a depth of 670 m); choose not to depart or be unable to depart the area; and/or be subjected to repeated exposures. In this regard, it is assumed that if an animal considered the sound to be annoying, it would depart the area during the 5-min source ramp-up period. All marine mammals have adequate swim speed to accomplish this.

Hollien (1993) suggests that the dynamic range of human hearing underwater is less than in air. However, there is no information as to whether the human range, or some lower (or higher) range, applies to marine mammals (Hollein, 1993). If a lower value is appropriate, then the received level that would cause an odontocete to incur TTS could be less than the assumed 150 dB (≤15 dB difference); if higher, 150 dB would be too conservative (≤15 dB difference).

According to Ketten, no current auditory data support a serious concern for permanent hearing damage to any odontocete, including the sperm whale. As with mysticetes, however, she notes that her conclusions are speculative, depending largely upon anatomical models for an approximation of hearing characteristics of most marine mammal species in question. She notes that such models appear to reliably estimate frequency, but are not yet proven indicators of sensitivity. Potential complications with the assumptions include the possibility that dolphins, which have better intensity discrimination than other mammals, may have hair cells that are more susceptible to acoustic trauma. Alternatively, the dolphin uses a nonconventional sound conduction pathway, surrounding head tissues are large, and there are acoustic isolation mechanisms within its head, all of which may provide significant passive or reflexive attenuation of potentially damaging sounds. She adds that substantially more research is needed on both the hearing mechanisms and audiometry of marine mammals, to develop definitive guidelines for safe limits on underwater signals.

Ketten (1994) stated that although the sperm whale might be expected to have good low frequency hearing, its inner ear resembles that of most dolphins, and is tailored for ultrasonic (>20 kHz) reception. She noted that based on inner ear anatomy, the predicted functional lower hearing limit for sperm whales is near 100 Hz, a prediction consistent with evoked response data from one stranded sperm whale (good sensitivity above 2.5 kHz). There are, however, indications that the sperm whale may have hearing capability at low frequencies (Carder and Ridgway, 1990), and it is known to be sensitive to changes in its acoustic environment (Watkins and Schevill, 1975; Watkins et al., 1985a). Sperm whales have been found to react to sounds at frequencies below 28 kHz, including 3.5 kHz submarine sonar signals (Watkins et al., 1993).

The only odontocete species on which underwater audiograms have been published are the killer whale (only down to 500 Hz), false killer whale (only down to 2 kHz), white whale, or beluga (down to 40 Hz), harbor porpoise (only down to 1 kHz), Amazon River dolphin (only down to 1 kHz), bottlenose dolphin (down to 75 Hz) (Johnson 1967; Awbrey et al., 1988;

Johnson et al., 1989; Thomas et al., pers. comm., 1994), and the Chinese river dolphin (baiji) (Wang, 1992). The beluga and Amazon River dolphin do not inhabit the proposed study area. The bottlenose dolphin has a hearing threshold of approximately 132 dB at 75 Hz (Johnson, 1986) (Figure 4.3.1.2.1-1). Beluga audiograms suggest poor audiometric and behavioral sensitivity to low frequency sounds, with diminishing sensitivity as frequency decreases from 20 kHz to 40 Hz (White et al., 1978; Awbrey et al., 1988; Johnson et al., 1989). White whale thresholds (which are similar in bottlenose dolphins) are about 102 dB at 1 kHz, 127 dB at 100 Hz, 132 dB at 57 Hz, and 140 dB at 40 Hz (White et al., 1978; Awbrey et al., 1988; Johnson et al., 1989).

White whales that winter in the Davis Strait area (between Greenland and Baffin Island) and summer in the Canadian high arctic show behavioral sensitivity to weak sounds from distant ships and icebreakers. Strong reactions have been seen to ships up to 35-50 km away when received noise levels were 94-105 dB (20 to 1000 Hz band) (LGL and Greeneridge, 1986; Cosens and Dueck, 1988). However, based on the hearing sensitivity profiles of these animals, it is likely that they were responding to that portion of the noise spectrum in mid-frequency ranges.

Preliminary data suggest that audiometric sensitivity to low frequency sound of Pacific white-sided dolphins may be slightly better than bottlenose dolphins or white whales, which are the two species previously tested at frequencies near that of the ATOC source (Thomas unpub., 1993). Studies are currently being conducted to obtain low frequency audiograms on bottlenose dolphins, Risso's dolphins, and false killer whales (Nachtigall and Au, pers comm., 1994).

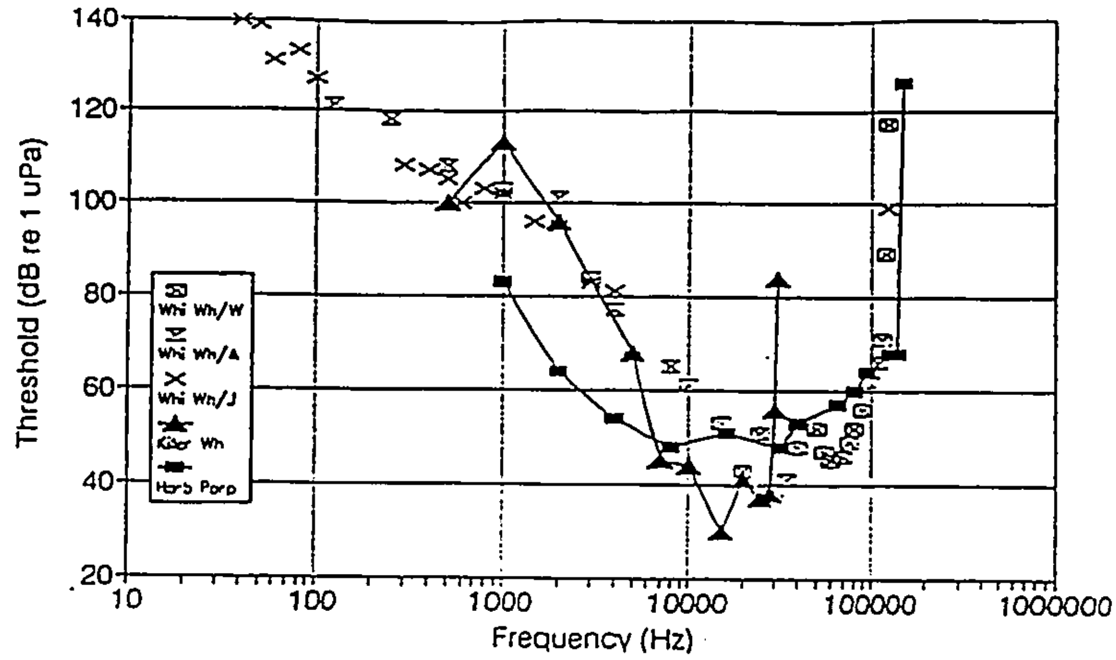
Preliminary audiometric data from Au and Nachtigall (pers. comm., 1995) indicate that the hearing threshold at 75 Hz for false killer whale and Risso's dolphin is no better than 145 dB.

Based on the above, it appears that the potential for physical auditory impact on odontocetes is minimal. At a relatively conservative threshold of 130 dB at ATOC frequencies, odontocetes would only hear the source within 5 km and TTS would not be expected at any location relative to the source. A possible exception may be the sperm whale, for which there appears to be some anecdotal evidence of reaction to low frequency sound, coupled with the fact that they are known to dive to depths exceeding 800 m.

Although it is believed that short-finned pilot whales are capable of diving to 610 m (Leatherwood and Reeves, 1983), no data exist on their frequency of making such deep dives, nor how long they would be expected to stay at depths >500 m (presumably for only short time periods).

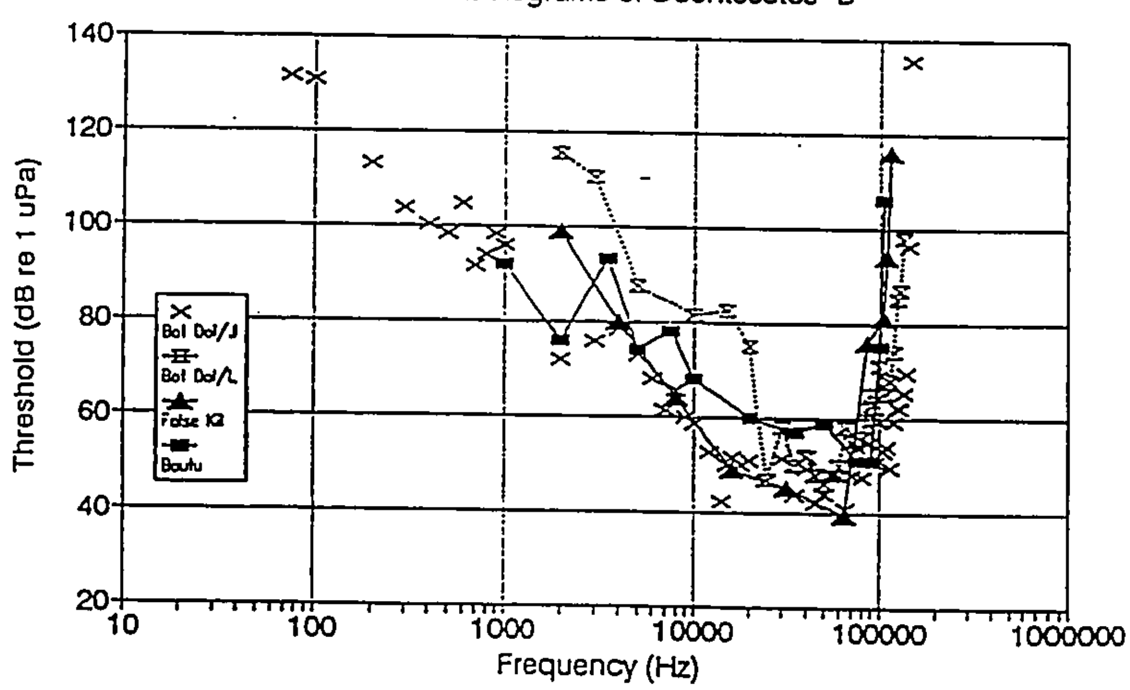
The low frequency hearing of pilot whales has not been studied and they could possibly inhabit the north Kauai offshore region. If their low frequency hearing thresholds are comparative with belugas or bottlenose dolphins, they may be able to hear the source transmissions near the surface, directly above the source.

Underwater Audiograms of Odontocetes–A



(From LGL OCS Study MMS 90-0093, 1991)

Underwater Audiograms of Odontocetes–B



(A) white whale (White et al. 1978, n=2; Awbrey et al. 1988*, n=3; Johnson et al. 1989); killer whale (Hall and Johnson 1972); harbor porpoise (Andersen 1970a);
(B) bottlenose dolphin (Johnson 1968a; Ljungblad et al. 1982c); false killer whale (Thomas et al. 1988); Amazon river dolphin or boutu (Jacobs and Hall 1972). n=1 except where noted. * Awbrey et al. (1986) reported higher-frequency data for these white whales, but these data did not represent sensitivity in the direction of best hearing.

Figure 4.3.1.2.1-1 Underwater audiograms of odontocetes /A and B

Beaked whales also are considered to be potentially capable of diving as deep as 1000 m. Most of what is known about all species of beaked whales comes from stranding records; they are rarely seen and difficult to identify at sea. Most animals of this species are thought to forage far offshore in waters >1000 m deep, feeding on mesopelagic fishes and squid (Leatherwood et al., 1987; Mead, 1989). Cuvier's beaked whales are the most widely distributed and frequently sighted beaked whales in the northeastern Pacific (Mead, 1984; Leatherwood et al., 1987); however, no seasonal movements can be inferred from the infrequent sightings or stranding data (Dohl et al., 1983). Furthermore, there are no data on hearing sensitivity of any beaked whales.

Rough-toothed dolphins stay submerged for a long as 15 min, and exhibit physical characteristics that may be adaptations to deep diving (large thorax and large eyes). Extensive white scars seen on many of these animals may be the result of close encounters with large, deep-water squid. Thus, there are no records of these animals diving >500 m, but physiological and feeding characteristics suggest the capability.

Thus, provided that sound field acoustic performance prediction computer models and the assumptions/criteria regarding TTS discussed previously are correct, it is highly unlikely that any odontocete species, with the possible exception of the sperm whale and other deep-diving odontocetes for which audiometric data do not exist, could experience physical auditory effects.

For sperm whales, only anecdotal evidence suggests they may have low frequency hearing capability. Even assuming that low frequency hearing of sperm whales is comparable to that of mysticetes, the fact that they make dives >670 m (i.e., to the depth of the 150 dB sound field of the ATOC source) in much deeper water (Rice, 1989), means that the potential for sperm whale encounters with the 150 dB sound field would be minimal. However, Watkins et al. (1993) noted that sperm whales off Dominica in the Atlantic Ocean appear to commonly dive almost to the bottom. Given the proposed 2% duty cycle of the ATOC source, with approximately 550 transmissions per year (1100 transmissions total for the two-year study period), and applying conservative assumptions concerning the percentage of time (10 to 20%) spent by sperm whales at depths below the top of the 150 dB zone (>800 m depth), the statistical probability of a sperm whale being exposed to the 150 dB sound field during the initial two-year study period is no more than 1%. The chance of repeated 150 dB or greater exposures to the same animal, expected to be required before significant hearing impacts result, is extremely small. As a result, any impacts would likely be confined to potential behavioral changes, with the possibility of an occasional temporary threshold shift.

Mitigation Measure 6-1: A MMRP will be carried out in connection with the ATOC project in accordance with the protocols set forth in Appendix C of this EIS. With regard to potential physical auditory and behavioral impacts on odontocetes, a goal of the MMRP will be to validate the assumptions regarding population distribution, abundance and diving behavior of sperm whales, which form the basis for predicting the potential for effects from the ATOC sound source.

• Potential for behavioral disruption: Odontocetes, like mysticetes, exhibit disturbance reactions such as cessation of resting, feeding, or social interactions and/or changes in surfacing, respiration, or diving cycles, and avoidance behavior. For example, they have been observed responding with both attraction and avoidance to noisy sources (Wursig, pers. obs., 1990), but they are also relatively unresponsive to noise at low frequency (Awbrey et al., 1983). As noted above, however, sperm whales may have reacted to sounds at low frequencies (unknown source levels, received levels approximately 100 dB) of submarine sonar signals at 3.5 kHz (Watkins et al., 1993). Bottlenose dolphins off Sarasota, Florida showed no significant reaction to acoustic signals where received levels were > 120 dB (Tyack et al, 1993).

Richardson et al. (1990b) used underwater playback techniques to test the effects of drilling sounds on white whales migrating through leads north of Alaska in spring. The test sounds were from a drillrig on a grounded ice platform, and were mainly below 350 Hz (source level 165 dB). Although the sounds were detectable with hydrophones as much as 5 km from the projector, no overt reactions were detected until the white whales were within 200-400 m. Within that distance, some diverted or hesitated for a few minutes, but then continued within 50-200 m of the operating underwater projector. However, white whales swimming along an ice lead in spring changed course when they came within 1 km of a stationary drillship, and exhibited more active avoidance when support vessels were moving near the drillship (Norton et al., 1982). This, together with the aforementioned results suggests that white whales may be especially sensitive when in ice leads during spring.

Stewart et al. (1983) tested reactions of white whales to underwater sounds projected into an Alaskan river. In most tests, the sound level increased rapidly (within 5 sec) from zero to maximum when whales were within 1.5 km. These whales usually swam faster in the same direction as before the playback. In some tests, respiration rates increased during playbacks. During two tests, sounds were projected continuously as whales approached from about 3.5-4.6 km upstream. In one test, there was no detectable reaction until the whales were within 50-75 m; in the second test, whales reacted at 300-500 m. Reactions included rapid swimming and, in one case reversal of direction. However, most whales passed close to the projector where received sound levels must have been high. Received levels in the shallow river were not measured, and were probably quite different than would occur at similar ranges in the ocean. Stewart et al. (1983) concluded that reactions to drillrig noise were less severe than those to motorboat noise.

Just prior to and during the Heard Island Feasibility Test (HIFT) that took place in January, 1991 (discussed in Section 1), experienced marine mammal observers conducted line-transect surveys and monitored marine mammal behavior visually and acoustically in a 70 x 70 km square centered on the transmission site. Bowles et al. (1994) reported that 39 groups of cetaceans were sighted both prior to and during the transmission periods, including sperm whales and other odontocetes (hourglass dolphin [*Lagenorhynchus cruciger*], Commerson's dolphin [*Cephalorhynchus commersoni*], dusky dolphin [*Lagenorhynchus obscurus*], killer whales, long-finned pilot whales [*Globicephala melas*], southern bottlenose whale [*Hyperoodon planifrons*], and Arnoux's beaked whale [*Berardius arnouxii*]). More schools of hourglass dolphins were sighted during transmissions, but fewer groups of pilot whales and southern bottlenose whales. There was no evidence that dolphins may have surfaced to avoid higher sound levels at depth.

The density of all cetaceans was 0.0157 groups/sq km before transmissions and 0.0166 groups/sq km during. Sperm whales and pilot whales were heard in 23% of 1181 min of baseline acoustic surveys prior to transmissions, and in none of the 1939 min during. Both species were heard within 48 hr after the test. It should be noted that there were fundamental differences between the acoustic characteristics of the HIFT source and that planned for ATOC research: 57 Hz center frequency (vs. 75 Hz for ATOC); 30 Hz bandwidth (vs. 35 Hz bandwidth for ATOC); 209-220 dB source level (vs. 195 dB for ATOC); 175 m depth (vs. 850 m for ATOC); 33% duty cycle (vs. 2%-8% for ATOC); and location in the upper water column (vs. seafloor-mounted for ATOC).

As with mysticetes, variations in sensitivity to human-made noise between and within odontocete species and the lack of information about the consequences of short-term disruptions on odontocetes make it very difficult to define criteria of responsiveness and to assess the consequences of a disruption in their natural activities.

The potential for short-term behavioral disruption, or displacement, is unlikely, although the sound transmissions of ≥130 dB would likely be audible to some animals within 5 km of the source. Potential effects on sperm whales and other deep-diving odontocetes are more uncertain.

Behavioral changes in odontocetes may occur in deep diving species that have good low frequency hearing. Given the relatively low sensitivity of most odontocetes to low frequency sounds (other than possibly sperm and beaked whales) and the relatively low density of many odontocete species in the study area, potential impacts on these species are anticipated to be minimal.

• Potential for habituation: As noted previously, relatively few studies of habituation in marine mammals have been done. In toothed whales, one apparent example of habituation is the tolerance by white whales of the many boats that occur in certain estuaries versus the extreme sensitivity of this species to the first icebreaker approach of the year in a remote area of the high arctic. Also, in certain areas, wild dolphins have become unusually tolerant of humans, and may even actively approach them (Lockyer, 1978; Conner and Smolker, 1985; Shane et al., 1986).

As discussed above, habituation generally helps moderate potential impacts, except if the habituation is generalized to include hazardous sources. Since most odontocetes hear well in mid and high frequency ranges, however, it is unlikely that habituation to the low frequency ATOC source would result in decreased avoidance of vessels, etc. As a result, no adverse impacts from habituation are anticipated.

• Potential for long-term effects: The discussion in Section 4.3.1.1.1 on the potential for and ramifications of long-term effects of underwater noise on mysticetes is relevant to odontocetes, as well.

In general, changes in marine mammal usage of an area could be quite slow and difficult to detect, and the causes of any changes may be difficult to discern. There are no documented instances of long-term effects of subsea sounds on odontocetes, but given the difficulties of obtaining such information, the potential for adverse impacts from long-term exposures to the ATOC source sound fields should be considered unknown. Although no such impacts are anticipated, marine mammal exposures to subsea sounds will be minimized whenever feasible.

• Potential for masking: The same general principles concerning masking discussed at the beginning of section 4.3 apply to odontocetes. As noted previously, virtually no specific information is available about the nature and effects of masking under field conditions nor about the adaptations that marine mammals may use to reduce masking by low frequency sounds. Based on studies of high frequency echolocation by toothed whales, echolocation signals are subject to masking by high frequency noises. However, echolocation would not be masked by most industrial noises (or ATOC sound transmissions), which tend to be concentrated at low frequencies. Significant masking only occurs for frequencies similar to those of the masking noise (Richardson et al., 1991).

As discussed by Richardson et al. (1991), the maximum radius of influence of an industrial noise (or ATOC sound transmission) on a marine mammal is the distance from the source at which the noise can barely be heard. This range is determined by either the hearing sensitivity of the animal, or the background noise level.

Studies on captive odontocetes by Au et al. (1974, 1985) indicated that some species may use various processes to reduce masking effects (e.g., adjustments in echolocation signal intensity and/or frequency as a function of background noise). However, inasmuch as echolocation and communication signals are of higher frequencies, they will not be masked by most industrial or other (e.g., ATOC) noises that are concentrated at low frequencies.

Although low frequency hearing has not been studied in many odontocete species, those species that have been tested (white whale, killer whale, false killer whale, and bottlenose dolphin) exhibit low audiometric and behavioral sensitivity to low frequency sound. It is not clear whether sperm and pilot whale vocalizations were masked by the 1991 HIFT acoustic signals, or if those species simply stopped emitting sounds during the test. Vocalization cessation would be expected with sperm whales because they frequently become silent in the presence of human-made noise (Watkins and Schevill, 1975; Watkins et al., 1985a). Thus, for sounds dominated by low frequency components, the maximum radius of audibility for most odontocete species often may be determined by their hearing sensitivity, rather than the background noise level. It appears, therefore, that with the possible exception of the sperm and pilot whale, the potential for increased masking for any odontocete, as a result of the proposed sound transmissions, is expected to be minimal.

There are no documented instances of masking of subsea sounds on odontocetes, and given the fact that odontocetes do not call at frequencies near the ATOC source frequencies, there would be very little, if any, potential for masking of odontocete calls by ATOC transmissions (Richardson, pers. comm., 1994). Although no such impacts are anticipated, marine mammal exposures to subsea sounds would be minimized whenever feasible.

• Potential for indirect effects: Indirect effects include those effects that potentially could be caused by the proposed action and are later in time, or farther removed in distance, but would still be reasonably foreseeable. The principal indirect effect in this case would be any potential impact on the food chain that could ultimately affect odontocetes in the vicinity of the study area. The sperm whale, pygmy sperm whale and dwarf sperm whale prey primarily on mesopelagic squids; the latter two also ingest some fish, octopus and crustaceans. The main food for pilot and beaked whales is squid and fish (e.g., rockfish, mackerel). The dolphins' staple food is usually squid or fish (e.g., anchovies, hake). Killer whales prey on almost any palatable marine organism of any size. Virtually all oceanic cetaceans, pinnipeds, seabirds, sea turtles (particularly leatherbacks), fish (especially herring and salmon), and even their own kind can be considered prey. The potential effects of the MMRP and low frequency sound transmissions on these prey species are addressed in this EIS and, as such, constitute the discussion of indirect effects on odontocetes.

For a discussion of potential direct, indirect, and cumulative impacts on fish which are prey species for most odontocetes, see Section 4.3.2.2. Impacts on squid, the prey species for sperm whales, pygmy sperm whales, dwarf sperm whales, pilot whales, beaked whales, melon-headed whales, false killer whales, pygmy killer whales, and dolphins, are discussed in Section 4.3.2.3. In addition, the impacts of the proposed project on the prey species for killer whales are discussed in the following sections: pinnipeds, Section 4.3.1.3; sea turtles, Section 4.3.2.1; fish, Section 4.3.2.2; and seabirds, Section 4.3.2.4.

It is believed that any potential effects on prey species would be incremental and affect only a small portion of the range. To further assess the potential for indirect impacts, the MMRP, to the extent feasible and practicable, would include observations of the potential impact of source operations on prey species.

The potential direct and indirect effects of the alternatives are summarized in Table 4.3.1.2.3-1.

4.3.1.2.2 Potential Cumulative Effects on Odontocetes

Activities that might reasonably be considered to have the potential to interact cumulatively to affect odontocete species that inhabit or travel through the proposed study area have been discussed in Section 4.3.1.1.2. They include commercial merchant shipping and other vessel-related activities, recreational water activities (as a result of the potential for ship/boat collisions and noise from ship/boat engines); and noise from aircraft. The discussions below also account for MMRP-related activities that could potentially cumulate with the source transmissions: 1) aerial visual surveys/observations, 2) shipboard acoustic surveys/observations.

• Merchant shipping and other vessel-related activities: Many odontocetes appear to be generally tolerant of ships and boats (although sperm and beaked whales generally attempt to avoid vessels), and attraction to boats by some toothed whale species is fairly common. Bottlenose dolphins, for example, frequently approach boats, swimming in their bow and stern waves (Shane et al., 1986), and are frequently seen in heavily trafficked ship channels (Braham et al., 1980; Shane, 1980).

Avoidance of vessels can occur, however, depending upon circumstances (e.g., when the animals are confined by ice or shallow water or when vessels are associated with harassment). Irvine et al. (1981), for example, reported that bottlenose dolphins previously captured for research purposes and later released, subsequently fled at the capture boat's return. Flaherty (1981), Barlow (1985), Silber et al. (1988), and Polocheck and Thorpe (1990) reported that harbor porpoises tend to avoid vessels. Silber et al. (1988) reported that the Gulf of California harbor porpoise surfaces for briefer periods when a boat is nearby, often exhibiting "rolling" behavior and respiring only once or twice per surfacing when near a boat. According to Kruse (1985), killer whales may change behavior when a vessel is within 400 m range. Papastavrou et al. (1989) found that sperm whales were not appreciably disturbed by a small motorized vessel when it was operated in a non-aggressive manner. However, Whitehead et al. (1990) observed startle reactions during attempts to closely approach sperm whales. Watkins and Schevill (1975) and Watkins et al. (1985a) found that sperm whales ceased emitting pulsed sounds when exposed to high frequency noise pulses (3-13 kHz) from ship pingers and sonars; although higher frequency pulses (>35 kHz) caused no reaction. As noted above, sperm whales have also exhibited reactions to high received levels (approximately 100 dB) of submarine sonar signals at 3.5 kHz (Watkins et al., 1993).

Collisions between boats and toothed whales apparently are not common, although they do occur. According to Reynolds (1985), vessel propellers were responsible for occasional bottlenose dolphin deaths in the Gulf of Mexico, and sperm whales have been victims of ship collisions as well (Slijper, 1962).

• Aircraft operations: Few data are available on the reactions of odontocetes to aircraft overflights; however, as with humpback whales, sensitivity to aircraft varies greatly, depending on the animals' activity. Bel'kovich (1960) and Kleinenberg et al. (1964) reported that white whales did not react to an aircraft flying at 500 m. However, when the aircraft descended to 150-200 m, they dove for longer periods, had shorter surface intervals, and sometimes swam away. Feeding white whales were reportedly less prone to disturbance, whereas lone animals dove even when the aircraft was at 500 m. Dohl et al. (1983) reported strong reactions (i.e., diving immediately and remaining submerged for long periods of time) by Baird's and Cuvier's beaked whales to a medium-sized Pembroke aircraft approaching or passing overhead at 60-305 m altitudes. However, sperm whales appeared unaware of a Cessna 310 observation aircraft overhead at 152 m altitude (Gambell, 1968).

• Research activities: The discussion in Section 4.3.1.1.2 of the potential for and, consequences of, ongoing and future research activities in the vicinity of the study area on mysticetes is relevant to odontocetes, as well.

Appendix C describes the MMRP aerial and vessel protocols that would be employed during research activities.

As with mysticetes, any cumulative impacts from other sources of subsea sounds or developments that affect the marine environment in the vicinity of the proposed action are speculative. Also, as with mysticetes, odontocetes may not respond to noise or other stressors until some threshold level is exceeded. The proposed source would not be expected to contribute materially to any cumulative effects.

4.3.1.2.3 Summary and Conclusions Concerning the Potential Effects on Odontocetes

This subsection summarizes the information presented in the previous subsections regarding potential effects of the ATOC source operations and the MMRP on odontocetes.

The sperm whale may be the odontocete with the greatest potential to experience any impacts from the source transmissions. Sperm whales dive to depths of more than 2000 m, remain submerged for an hour or more, and are usually found in the ocean beyond the 1000 m depth contour. Therefore, it is conceivable that sperm whales could be exposed to maximum source transmissions, which could theoretically cause temporary threshold shift. Although, limited data indicate that sperm whales may be able to hear frequencies as low as 100 Hz, the construction of their inner ear indicates best reception of very high frequency, ultrasonic, sounds. Further, the sounds produced by sperm whales center around two frequency bands, 2-4 kHz and 10-16 kHz (see Section 4.3.1.2.1 for a discussion of possible functions of these sounds), well above the frequency of the ATOC source transmissions. Therefore, it is unlikely that the ATOC transmissions would interfere with, or mask, usual sperm whale sounds (Richardson, pers. comm., 1994). Although the low frequency source used during the HIFT apparently caused sperm whales to cease vocalizing (during transmissions--they started back up again within 48 hrs after the end of the test), that source's characteristics were different from the currently proposed ATOC source's (see above). Although not anticipated, if ATOC source transmissions did cause sperm whales to modify their vocalizations, it could possibly affect their echolocation clicks, which have also been suggested to convey information about their age, sex and reproductive status.

Research on killer whales indicates that they hear in the mid-frequency range, down to at least 500 Hz. However, if killer whales follow the pattern of most other odontocetes, low frequency hearing capabilities are anticipated to be poor, so even closer proximity to the ATOC source would be required for a TTS, as compared to mysticetes. Moreover, they are not believed to dive deep enough to get close enough to the source to possibly incur TTS (i.e., >670 m). Densities of killer whales in the Hawaiian Island region are low; i.e., less than one animal per 5000-10,000 sq km. As a result of the aforementioned factors, and a 2% duty cycle, the statistical probability of close encounters by killer whales with the ATOC source that could produce a TTS is negligible. The potential for behavioral effects (e.g., masking, modifying vocalization patterns, etc.) is believed to be very low.

Beaked whales are believed to be able to dive to 1000 m. They are usually found in offshore waters, in depths >1000 m, and are thought to hear primarily in the high frequency band. Although they might be exposed to the maximum source transmissions, their expected inability to hear in low frequencies, and their rarity reduces the probability of potential physical auditory impacts. The potential for behavioral effects (e.g., masking, modifying vocalization patterns, etc.) is believed to be very low.

Short-finned pilot whales are believed capable of diving to 610 m, but their estimated abundance in the ETP is only about 60,000 individuals (Evans, 1987). This equates to one animal every 500 km2 which, in turn, means the potential for an animal (or group of animals) to be in the vicinity of the source during the 2-8% of the time it would be transmitting, and diving to > 670 m depth at that specific time, is quite small. Pilot whales' behavior may have been affected off Heard Island in 1991, when anecdotal evidance indicated some may have stopped calling and/or moved away in response to distant seismic ship and/or HIFT transmissions (Bowles et al., 1994).

No records of rough-toothed dolphins diving >500 m exist, although the possibility exists (since bottlenose dolphins may be able to dive to 535 m). Though widely distributed, its population size is unknown, and is apparently nowhere abundant (Evans, 1987). Therefore, it can be assumed that its densities are lower than pilot whales, which should equate to a minimal potential for impact from the proposed source tranmissions.

Generally, based on what is known of the relative distribution and abundance of species at the alternate sites, the Johnston Atoll alternative would be expected to have a decreased potential for impacts due to projected smaller populations of marine mammals generally. In addition, the moored autonomous source alternative, which would both use sources buoyed up from the seafloor, could possibly result in more close encounters with sperm and beaked whales due to their diving behavior (although moored autonomous sources possibly could be placed in an area believed devoid of sperm and beaked whales). The no action alternative would have no impacts.

Table 4.3.1.2.3-1 summarizes the potential direct and indirect effects, and potential cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS)	Assumptions: • Odontocete hearing sensitivity good at high frequencies. Audiograms on 7 species suggest low audiometric/behavioral sensitivity to low frequency sounds. Some anecdotal evidence of low frequency hearing capability in sperm whales, although anatomically their inner ear is tailored for ultrasonic (>20 kHz) reception. • Odontocetes in study area that might be capable of diving to depths >670 m, deep enough to enter the 150-195 dB sound field, include sperm, short-finned pilot, pygmy sperm, dwarf sperm, and some beaked whales, and rough-toothed dolphins. • For TTS or PTS to occur, animal should be capable of hearing signals below 90 Hz, with hearing sensitivity below (better than) 70 dB for frequencies below 90 Hz (assuming TTS would occur at received levels ≥80 dB above absolute threshold).	Assumptions: • No physical auditory effects on odontocetes due to the MMRP or ATOC source transmissions. • Any physical auditory effects of indigenous low frequency sound sources (ships, boats, planes, etc.) on odontocetes would continue.	Assumptions: • Odontocete hearing sensitivity good at high frequencies. Audiograms on 7 species suggest low audiometric/behavioral sensitivity to low frequency sounds. Some anecdotal evidence of low frequency hearing capability in sperm whales, although anatomically their inner ear tailored for ultrasonic (20 kHz) reception. • For TTS or PTS to occur, animal should be capable of hearing signals below 90 Hz, with hearing sensitivity below (better than) 70 dB for frequencies below 90 Hz (assuming TTS would occur at received levels ≥80 dB above absolute threshold). • Assume sound field characteristics and duty cycles comparable to Kauai alternative.	Assumptions: • Odontocete hearing good at high frequencies. Audiograms on 7 species suggest low audiometric/behavioral sensitivity to low frequency sounds. Some anecdotal evidence of low frequency capability in sperm whales, although anatomically their inner ear tailored for ultrasonic reception. • For TTS or PTS, animal should be capable of hearing below 90 Hz, with hearing sensitivity below (better than) 70 dB at <90 Hz (assuming TTS would occur at ≥80 dB above absolute threshold). • Cannot assume sound fields comparable to Kauai or Johnston Atoll alternatives because of source characteristic differences. • Probably lower density of odontocetes in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset benefit of fewer odontocetes.
	Very Low for shallow-divers (<670 m) provided assumptions are correct. Uncertain but presumed Low for deep-divers (>670 m)	*None*	*Very Low for shallow-divers (<670 m) provided assumptions are correct. Uncertain but presumed Low for deep-divers (>670 m)*	*Unknown*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Behavioral disruption and Habituation	Assumptions: • Sound fields: - 120 dB 12 km shoreward, 7.5 km seaward from source. - 130 dB 5 km around source. - 135 dB 1000 m around source. - 145 dB at 534 m depth (316 m range around source) - 165 dB at 820 m depth (30 m range around source) - 195 dB at 850 m depth (1 m range around source). • Duty cycles 2%-8%. • Available data indicate odontocetes relatively unresponsive to LF noise. Some anecdotal evidence of LF hearing capability and possible minor behavioral reactions to seismic/HIFT RLs ≤120 dB in sperm whales and pilot whales. • Maximum residence time within 120 dB area for any odontocete expected to be <24 hrs. • Wide variations in sensitivity to human-made noise between and within odontocete species, due to physical and/or biological factors. • Animals may tolerate and habituate to noise <135 dB at surface near source, and higher at typical dive depths, for 2%-8% duty cycles.	Assumptions: • No potential behavioral disruption or habituation due to MMRP or ATOC source transmissions. • Direct effects of indigenous low frequency sound sources in the area would continue.	Assumptions: • Sound fields and duty cycles comparable to Kauai alternative. • Available data indicate odontocetes to be relatively unresponsive to low frequency noise. Some anecdotal evidence of low frequency hearing in sperm whales. • Maximum residence time within ensonified area for any individual odontocete expected to be < 24 hrs; few expected to remain more than 3 hrs. • Wide variations in sensitivity to human-made noise between and within odontocete species, due to physical and/or biological factors. • Odontocetes may tolerate noise levels <130 dB at 2%-8% duty cycle. Potential for habituation if animals perceive noise as non-threatening. • Odontocetes more likely to habituate to constant, predictable noise source.	Assumptions: • Sound fields and duty cycles as described above. • Available data indicate odontocetes to be relatively unresponsive to low frequency noise. Some anecdotal evidence of low frequency hearing in sperm whales. • Residence time within ensonified area for any individual odontocete cannot be estimated. • Wide variations in sensitivity to human-made noise between and within odontocete species, due to physical and/or biological factors. • Odontocetes may tolerate noise levels <130 dB at 2%-8% duty cycle. Potential for habituation if animals perceive noise as non-threatening. • Odontocetes more likely to habituate to a constant, predictable noise source.
	Very Low for shallow-divers (<670 m) provided assumptions are correct. Uncertain but presumed Low for deep-divers (>670 m)	*None*	*Very Low for shallow-divers (<670 m) provided assumptions are correct. Uncertain but presumed Low for deep-divers (>670 m)*	*Unknown*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Repeated disturbance could result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual animals are unknown. • Residence time in area as described above. • Potential for stress from noise exposure to sound levels ≤135 dB at surface near sound source, and higher at typical dive depths, at 2%-8% duty cycles is uncertain. • Low densities of deep-diving, low frequency capable animals	Assumptions: • No long-term effects due to MMRP or ATOC source transmissions. • No research would be done to assess long-term displacement caused by other low frequency noise sources.	Assumptions: • Repeated disturbance could result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual animals are unknown. • Residence time in area as described above. • Assume sound field characteristics and duty cycles comparable to Kauai alternative. • Potential for stress from noise exposure to sound levels ≤135 dB at surface near sound source, and higher at typical dive depths, at 2%-8% duty cycles is uncertain. • Low densities of deep-diving, low frequency capable animals	Assumptions: • Repeated disturbance could result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate negative energetic consequences for individual animals are unknown. • Residence time in area as described above. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably lower density of odontocetes could be expected in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer odontocetes.
	Uncertain, but presumed Low, provided assumptions are correct.	*None*	*Uncertain, but presumed Low, provided assumptions are correct.*	*Unknown*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Masking	Assumptions: • Sound fields and duty cycles as described above. • Odontocetes adapted for very high frequency sound pulses for echolocation and moderately high frequency calls for communication; most sensitive to sounds >10 kHz. Frequency range of sperm whale clicks from <100 Hz to 30 kHz. *None, provided assumptions are correct.*	Assumptions: • No increase in masking for odontocetes due to addition of MMRP and ATOC source to the indigenous low frequency sound sources in the area. • Effect of current and future local low frequency noise sources on odontocetes' masking would continue. *None*	Assumptions: • Odontocetes adapted for very high frequency sound pulses for echolocation and moderately high frequency calls for communication; most sensitive to sounds >10 kHz. Frequency range of sperm whale clicks from <100 Hz to 30 kHz. • Assume sound field characteristics comparable to Kauai alternative. *None, provided assumptions are correct.*	Assumptions: • Odontocetes adapted for very high frequency sound pulses for echolocation and moderately high frequency calls for communication; most sensitive to sounds >10 kHz. Frequency range of sperm whale clicks from <100 Hz to 30 kHz. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably lower density of odontocetes could be expected in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer odontocetes. *Unknown*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect odontocetes. • Sperm, pygmy sperm, and dwarf sperm whales prey mainly on mesopelagic squid; latter two also eat fish and crustaceans. • Pilot, beaked, and melon-headed whales prey on squid and fish. • Dolphins consume fish mostly. • Killer whales prey on all marine animals, particularly marine mammals. • False and pygmy killer whales injest squid and fish mostly. • Minimum impact on any of odontocetes' prey species is expected.	Assumptions: • No indirect effects due to MMRP or ATOC source transmissions. • Any current indirect effects on odontocetes would continue unabated.	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect odontocetes. • Sperm, pygmy sperm, and dwarf sperm whales prey mainly on mesopelagic squid; latter two also eat fish and crustaceans. • Pilot, beaked, and melon-headed whales prey on squid and fish. • Dolphins consume fish mostly. • Killer whales prey on all marine animals, particularly marine mammals. • False and pygmy killer whales injest squid and fish mostly. • Minimum impact on any of odontocetes' prey species is expected.	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect odontocetes. • Sperm, pygmy sperm, and dwarf sperm whales prey mainly on mesopelagic squid; latter two also eat fish and crustaceans. • Pilot, beaked, and melon-headed whales prey on squid and fish. • Dolphins consume fish mostly. • Killer whales prey on all marine animals, particularly marine mammals. • False and pygmy killer whales ingest squid and fish mostly. • Minimum impact on any of odontocetes' prey species is expected.
	Low, provided assumptions are correct.	*None*	*Low, provided assumptions are correct.*	*Low, provided assumptions are correct.*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. **• Recreational water activities.** **• Marine and nearshore construction and resort operations.** **• Aircraft operations** **• Research activities**	Assumptions: • Resident population of spinner dolphins north of Kauai. Spotted, bottlenose, rough-toothed dolphins, false killer, and pilot whales common to area. Sperm whales have been sighted in Hawaiian waters. • Higher proportion of population(s) likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources should increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. • Available data indicate odontocetes to be relatively unresponsive to LF noise. Some evidence of LF hearing capability in sperm whales. • Many odontocetes (with exception of sperm and beaked whales) are generally tolerant of vessel activities; sensitivity to aircraft varies greatly among and within species.	Assumptions: • No cumulative effects due to MMRP or ATOc source transmissions. • All other noise-related activities would continue to contribute to cumulative effects on odontocetes.	Assumptions: • Odontocete population and movement patterns around Johnston Atoll has not been studied. • Higher proportion of population(s) likely to be affected as number of noise sources increase; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources should increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known cumulative sources. • Long-term consequences of multiple noise sources likely to depend, in part, on degree to which animals habituate to repeated noise exposure. • Available data indicate odontocetes relatively unresponsive to low frequency noise. Some evidence of low frequency hearing in sperm whales. • Many odontocetes (with exception of sperm and beaked whales) are generally tolerant of vessel activities; sensitivity to aircraft varies greatly among and within species.	Assumptions: • Odontocete population and movement patterns around potential moored autonomous source sites is unknown. • Higher proportion of population(s) likely to be affected as number of noise sources increase; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources should increase the potential for masking. • Cumulative increases in impacts are speculative due to lack of known cumulative sources. • Long-term consequences of multiple noise sources likely to depend, in part, on degree to which animals habituate to repeated noise exposure. • Available data indicate odontocetes to be relatively unresponsive to low frequency noise. Some evidence of low frequency hearing capability in sperm whales. • Many odontocetes (with exception of sperm and beaked whales) are generally tolerant of vessel activities; sensitivity to aircraft varies greatly among and within species.
	Uncertain, but presumed Low, provided assumptions are correct.	*None*	*Uncertain, but presumed Low, provided assumptions are correct*	*Unknown*

Note: Because of anecdotal evidence that sperm whales may have LF hearing capability, and have been sighted in the vicinity of the Hawaiian Islands, this species is considered the indicator species for research purposes.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.1.2.3-1. Potential direct and indirect, and cumulative effects on odontocetes.

4.3.1.3 Pinnipeds

This section focuses on the potential impacts of the proposed action on pinnipeds, a suborder of marine mammals which includes seals, sea lions, and walruses. The Hawaiian monk seal is the only pinniped found in the proposed study area. However, because research on the monk seal is limited, this section includes a review of research on other pinnipeds as well. More information about these animals' habitat and distribution is found in Section 3, and is not repeated here.

Since pinnipeds are the prey of killer whales and sharks (an odontoceteand a fish) the following sections on the potential direct, indirect, and cumulative impacts of the proposed project on pinnipeds are also a discussion of indirect impacts on killer whalesand sharks. Pinnipeds are also the prey of some sharks, so this section also constitutes a discussion of the indirect effects of the proposed project on sharks.

It appears that monk seals spend somewhere between 40% and 60% of their time hauled out (Reeves et al., 1992). They have been seen hauled out on, and immediately offshore of, Kauai, Niihau, the Big Island, and Oahu. Adult males generally go to sea in the evenings, feeding at night, returning to haul out at mid-morning. Sometimes they remain at sea continuously for several days and nights. During mating season (May-October), both males and females probably spend more time ashore, even though mating is presumed to occur in the water (Reeves et al., 1992). During pupping season (December-August) and the subsequent 5-6 week weaning period, mothers would tend to spend most of their time ashore.

Although Hawaiian monk seals are seen around Kauai, most of the population inhabits the northwestern Hawaiian Islands, where the project source would be inaudible to them. There are at least 2-3 resident animals on Kauai (Nitta, pers. comm., 1995). There were, among others, three sightings around the island in 1993--none in the area off the north shore; and one sighting off the north shore during 1994 Marine Mammal Research Program shore-based visual surveys and observations (Smultea et al., 1994).

As noted previously, transmissions from the proposed sound source would generate a received level of 136 dB directly above the source itself (received level is not expected to exceed 136 dB at the water's surface anywhere in the vicinity of the source). Other received level values would be: 130 dB to a radius of 5 km; 120 dB to 12 km shoreward and 7.5 km seaward from the source; and 110 dB to 55 km seaward. Below the surface, sound levels are expected to be: 140 dB at 288 m depth (562 m range around the source); 145 dB at 534 m depth (316 m range around the source); 150 dB at 672 m depth (178 m range around the source); 165 dB at 820 m depth (30 m range around the source); and 195 dB at 850 m depth (1 m range around source).

As with mysticetes and odontocetes, the proposed action has the potential to adversely affect pinnipeds, directly and/or indirectly, as a result of noise disturbance during source sound transmissions. It also has the potential to contribute to cumulative effects, including disturbance as a result of associated aerial surveys or observations.

4.3.1.3.1 Potential Direct and Indirect Effects on Pinnipeds

Direct and indirect effects of low frequency noise on pinnipeds, including the potential for auditory interference by masking, temporary threshold shifts, behavioral disruption, long-term effects, and adverse impacts on the food chain (indirect effects) are discussed below.

• Hearing capabilities and sound production of pinnipeds: Phocid (hair) seal sounds seem to be associated with mating, mother-pup interactions, and territoriality; thus, underwater calls may not be very important for species such as elephant seals that perform most of these activities on land. Some phocid seals produce intense underwater sounds that may propagate for great distances (Burns, 1967; Ray et al., 1969; Watkins and Ray, 1977); whereas other species produce faint and infrequent sounds (Schevill et al., 1963). Phocids probably hear underwater sounds at frequencies up to approximately 60 kHz. Vocalizations between 90 Hz and 16 kHz have been reported (Table 4.3.1.3.1-1), but it is possible that other high frequency sounds were missed (Richardson et al., 1991), because of recording equipment frequency limitations. On land, monk seals make "bubbling" sounds; females also bellow with their mouth open when trying to drive away another seal or to protect her pup (Reeves et al., 1992). No underwater monk seal sounds have been studied in detail to date.

Within the pinniped suborder, none of the species tested to date have exhibited good hearing capabilities at low frequencies, although the northern elephant seal, California sea lion and harbor seal appear to communicate within the mid-frequency band (100-1000 Hz) (Schusterman et al., 1967). Underwater audiograms are available for several species of pinnipeds (Figure 4.3.1.3.1-1):

Phocids

- harbor seal [Mohl, 1968])
- ringed seal [Terhune and Ronald, 1975]
- harp seal [Terhune and Ronald, 1972]
- Hawaiian monk seal [Thomas et al., 1990]

Otariids

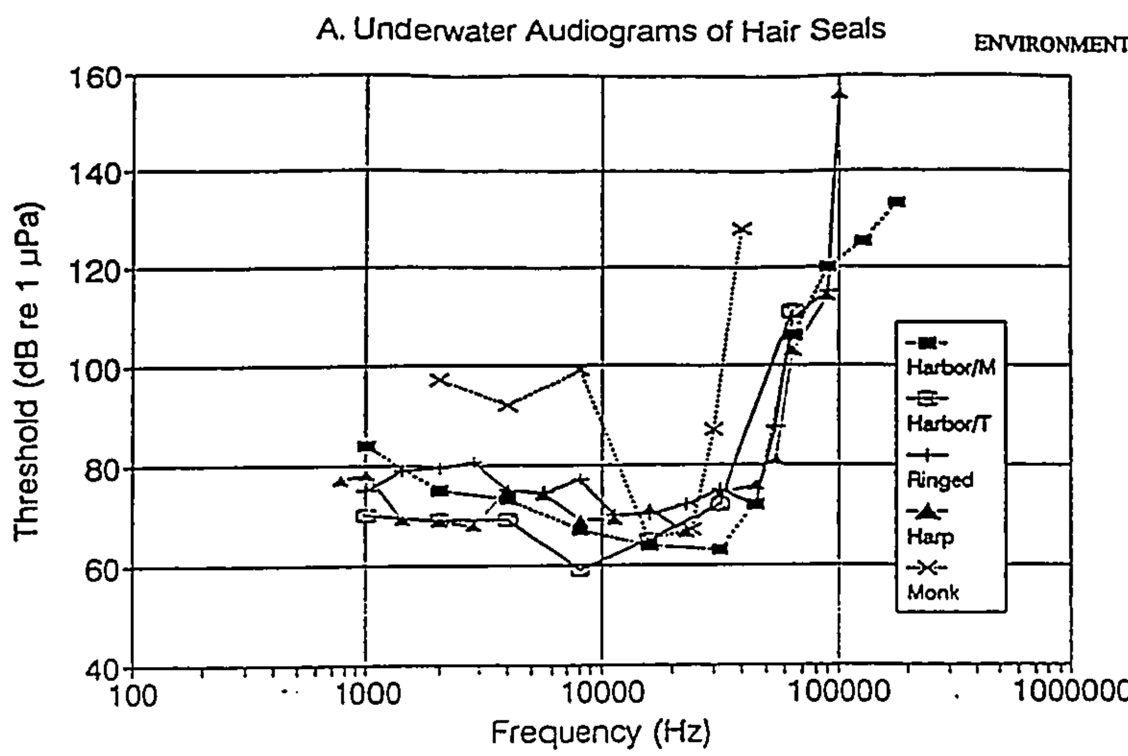
- California sea lion [Schusterman et al., 1972]
- northern fur seal [Poulter, 1968; Moore and Schusterman, 1987]

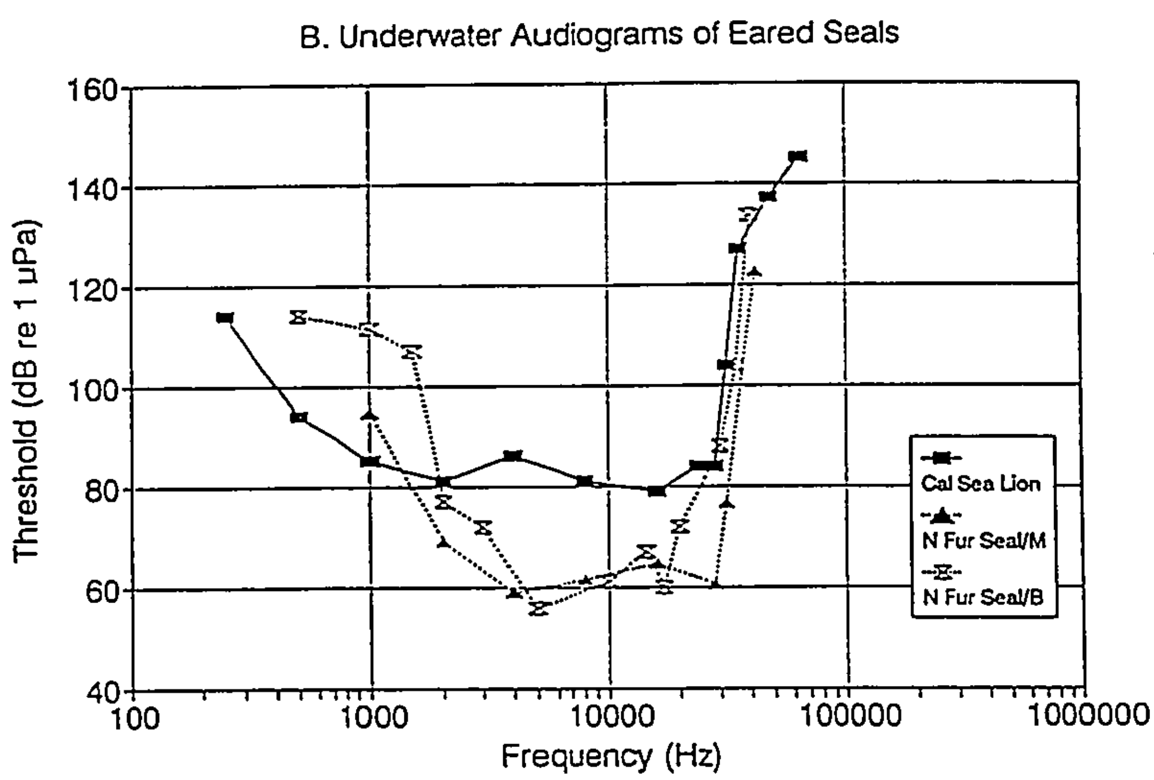
Published literature does not delineate the lower limit of phocid hearing, since frequencies below 760 Hz have not been applied in published test protocols, at least in part due to the acoustical limitation of small observation tanks and pools. However, based on the

Species	Signal type	Frequency Range (kHz)	Dominant Frequencies (kHz)	Source Level (dB re 1 μPa at 1 m)	References
Phocids[a]					
Bearded seal	song	0.02-6	1-2	178	Ray et al. 1969; Stirling et al. 1983; Cummings et al. 1983
Ribbon seal	frequency sweeps	0.1-7.1	-	160 (estimated)	Watkins and Ray 1977
Harp seal	15 sound types	<0.1-16+	0.1-2	130-140	Mohl et al. 1975; Watkins and Schevill 1979; Terhune and Ronald 1986
	clicks	-	30	131-164	Mohl et al. 1975
Ringed seal	barks, clicks, yelps	04.-16	<5	95-130	Stirling 1973; Cummings et al. 1984
Harbor seal and Spotted seal	social sounds	0.5-3.5	-	-	Beier and Wartzok 1979
	clicks	8-150+	12-40	-	Schevill et al. 1963; Cummings and Fish 1971; Renouf et al. 1980; Noseworthy et al. 1989
Gray seal	clicks	0.1-30	-	-	Schevill et al. 1969; Oliver 1978
	hiss	0.1-40	-	-	Oliver 1978
Hawaiian Monk seal	snorts, bubbling, bawling bellowing	-	-	-	Reeves et al. 1992
Otariids*					
California sea lion	barks	<3.5	<8	-	Schusterman et al. 1967
	whinny	<1-3	-	-	Schusterman et al. 1967
	clicks		0.5-4	-	Schusterman et al. 1967
	buzzing	<1-4	<1	-	Schusterman et al. 1967
Northern fur seal	clicks, beats	-	-	-	Poulter 1968
Steller sea lion	clicks, growls	-	-	-	Poulter 1968
Walrus	bell tone	0.4-1.2	-	-	Schevill et al. 1966
	clicks	0.4-10	-	-	Ray and Watkins 1975

[a] Underwater sounds of monk and elephant seals, and of Guadalupe fur seals, have not been described.
(from Richardson et al., 1991)
Note: Hawaiian Monk seal is the only pinniped found in Hawaiian waters.

Table 4.3.1.3.1-1 Characterstics of underwater sounds produced by northern hemisphere pinnipeds





(A) Hair seals - harbor seal (Møhl 1968a; Terhune 1989a); ringed seal (Terhune and Ronald 1975a, n=2); harp seal (Terhune and Ronald 1972); monk seal (Thomas et al. 1990b);
(B) Eared seals (otariids) - California sea lion (Schusterman et al. 1972); northern fur seals (Moore and Schusterman 1987, n=2 n=1 except where noted.

Figure 4.3.1.3.1-1 Underwater audiograms of pinnipeds /A and B available audiograms, phocids can hear frequencies at least as low as 1 kHz (Schusterman, 1981), with harbor seals testing as low as 760 Hz (Renouf, 1991). This, however, does not seem to apply to the only endemic pinniped in the Hawaiian Islands, the Hawaiian monk seal, based on the results of the study of underwater hearing by Thomas et al. (1990), which indicated that this species hears poorly at lower frequencies. That study, on a young male monk seal, showed that the animal's hearing was most sensitive (20 dB above maximum sensitivity) between 12 and 28 kHz, and that below 8 kHz, its hearing was less sensitive than any other pinniped tested. Variation among audiograms of different phocid species may be similar to that among audiograms of individual humans (Terhune, 1981).

With respect to otariids, at 250 Hz, the audiograms show the threshold of a California sea lion to be approximately 115 dB (Schusterman et al., 1972).

Kastak and Schusterman's unpublished data on audiometric experiments in air and water at 100 Hz for the harbor seal and California sea lion indicate hearing threshold levels <130 dB. Other Schusterman efforts (in progress) involve testing auditory-thresholds of northern elephant seals. In an in-air study, a TTS at 100 Hz was observed and quantified in a harbor seal after continuous exposure to broadband noise with an average source level of 85-90 dB (air standard) (equating to 147-152 dB in water), peaking at 95 dB (air standard) (157 dB in water).

In comparing data for pinnipeds with those for odontocetes, it appears from the slopes of the audiograms at the lowest frequencies tested that certain pinnipeds (e.g., California sea lion) may have better hearing sensitivity at lower frequencies than the beluga whale and bottlenose dolphin, for which low frequency audiograms are available. Schusterman's work (unpub. data, 1994) substantiates this.

• Potential for physical auditory effects: As discussed earlier in section 4.3.1.1.1, based on currently available data on acoustic trauma and the structure/mechanics of the marine mammal ear, Ketten (1994) theorized that for TTS to occur with regard to the proposed sound source (provided sound field calculations are correct) the animal must be :

- capable of hearing signals below 90 Hz and have hearing sensitivity below (better than) 70 dB (150 dB-80 dB=70dB) for frequencies below 90 Hz (assuming that TTS would occur for received levels >80 dB above the absolute threshold, as for humans listening in air).

- capable of diving deeper than 670 m (2200 ft) (making the same assumption as above). The only pinniped in Hawaiian waters, the Hawaiian monk seal, has recently been detected diving to at least 500 m (Ragen, pers. comm., 1985).

- within the 150 dB isopleth (a radius of 178 m from the source at a depth of 670 m); choose not to depart or be unable to depart the area; and/or be subjected to repeated exposures. In this regard, it is assumed if an animal considered the sound to be annoying, it would depart the area upon onset of the 5 min source ramp-up period. All marine mammals have adequate swim speed to accomplish this.

Thus, based on extrapolation of the available audiometric data (hearing threshold at 75 Hz would be >100 dB), and provided that sound field predictions and the assumptions/criteria regarding TTS discussed previously are correct (i.e., to suffer TTS, an animal would have to be exposed to >180 dB received level; for PTS to occur, an animal would have to be exposed to a level measurably higher than 180 dB or be subject to repeated TTS episodes), and given the low density of this species, the potential for a monk experiencing physical auditory effects is remote.

Mitigation Measure 7-1: A MMRP will be carried out in connection with the project in accordance with the research protocols set forth in Appendix C to this EIS. With regard to potential physical auditory impacts on the one pinniped species endemic to the Hawaiian Islands, the Hawaiian monk seal, a goal of the MMRP would be to validate the assumptions regarding population distribution in the study area (via aerial visual surveys), which form the basis for predicting the likelihood of potential impacts due to the ATOC source transmissions.

• Potential for behavioral disruption and habituation: There has been little study of potential pinniped behavioral disruption due to low frequency underwater sound transmissions. It has been reported that harbor seals continued to haul out in Kachemak Bay, Alaska during construction of hydroelectric facilities 1.6 km away (Roseneau and Trugden in Johnson et al., 1989, and in Malme et al., 1989). Kingsley (1986) found no evidence that numbers of ringed seals were lower adjacent to artificial island oil drilling and production sites. However, Frost and Lowry (1988) reported a reduction in numbers of ringed seals within 3.7 km of artificial islands, on some of which oil drilling operations were underway. Gales (1982) and McCarty (1982) reported that sea lions were common around oil production platforms off California and in Cook Inlet, Alaska. In spring, some ringed and bearded seals approached and dove within 50 m of an underwater sound projector broadcasting steady low frequency (<350 Hz) drilling sound (Richardson et al., 1991a). At that distance, the received sound level at depths greater than a few meters was approximately 130 dB.

With respect to noise from seismic exploration activities, Richardson et al. (1991) noted that there is evidence that some ringed seals abandon areas where on-ice seismic techniques (Vibroseis) are used in winter. However, the effect is very localized, and other species of seals often tolerate intense noises.

No detailed studies of reactions by pinnipeds to noise from seismic exploration in open water have been published. During seismic exploration at Sable Island, Nova Scotia, gray seals exposed to noise from airguns did not react strongly (Parsons and Sundberg, 1985); however, no details were given as to whether the seals that were exposed were in the water or hauled out.

The available information indicates that seals in the water sometimes tolerate intense impulsive sounds with strong low frequency content when they are strongly attracted to an area for feeding, reproduction, or other natural function. They also often tolerate more-or-less steady or transient sounds at lower intensities (Richardson, pers. comm., 1994).

As with mysticetes and odontocetes, variations in sensitivity to human-made noise between and within pinniped species and the lack of information about the consequences of short-term disruptions on pinnipeds, make it very difficult to define criteria of responsiveness in them and to assess the consequences of a disruption in their natural activities. In light of available data on pinniped low audiometric and behavioral sensitivity to low frequency sound (particularly in the case of the Hawaiian monk seal), and given the low densities of monk seals, the potential for short- or long-term effects as a result of the proposed sound transmissions is considered minimal.

• Potential for long-term effects: The discussion of the potential for and, ramifications of, long-term effects with respect to mysticetes and odontocetes also is relevant to pinnipeds. In general, changes in marine mammal usage of an area may be quite slow and difficult to detect, and the causes of any changes difficult to discern. There are no documented instances of long-term effects of subsea sounds on pinnipeds. Existing information suggests that pinnipeds habituate quite readily to noisy environments. However, given the difficulties of obtaining such information, the potential for adverse impacts from long-term exposures to the proposed source sound fields should be considered unknown. Although no such impacts are anticipated, marine mammal exposures to subsea sounds would be minimized whenever feasible.

• Potential for masking: The same general principles concerning masking discussed at the beginning of Section 4.3 apply to pinnipeds, as well. As noted, the maximum radius of influence of an industrial (or proposed source transmission) noise on a marine mammal is the distance from the noise source at which the noise can barely be heard. This distance is determined by either the hearing sensitivity of the animal, or the background noise level present. For many pinnipeds (e.g., fur seal, harbor seal), the radius of audibility of higher frequency, human-made sounds (e.g., 5-30 kHz), would normally be limited by the background noise level, since these species are more sensitive to high than to low frequency sounds. For sounds dominated by low frequency components, the maximum radius of audibility for these species may often be determined by their hearing sensitivity, rather than the background noise level. As any human-made noise that is above both the background ambient and the auditory threshold has the potential to mask (considering comparable bandwidths), there is the possibility of some masking for a seal within a zone of a few kilometers radius from the source.

However, in light of the relatively brief and intermittent nature of the proposed source transmissions, the belief that this species does not hear well at low frequencies, and its low densities, it appears that the potential for increased masking for the Hawaiian monk seal, as a result of the proposed sound transmissions, is very low.

• Potential for indirect effects: Indirect effects include those effects that potentially could be caused by the proposed action and are later in time, or farther removed in distance, but would still be reasonably foreseeable. The principal indirect effect in this case would be the potential impact on the food chain that could ultimately affect the one pinniped in the Hawaiian Islands.

The common prey species for the Hawaiian monk seal are benthic and reef-dwelling fish and invertebrates, including flatfish, scorpenids, eels, octopuses, and spiny lobsters (Reeves et al., 1992). If low frequency sound transmissions were to affect any of these prey species, depending on the extent to which their availability might be altered, there could be negative consequences to the pinniped population in the Hawaiian Islands. However, since at most only a very minor portion of the range (within approximately 5 km [130 dB sound field] of the source site) of these prey species would be affected, indirect impacts would likely be minimal. See Sections 4.3.2.2 and 4.3.2.3 for a discussion of potential impacts on prey species.

4.3.1.3.2 Potential Cumulative Effects on Pinnipeds:

Activities that might reasonably be considered to have the potential to interact cumulatively to affect the one pinniped species have been discussed in Section 4.3.1.1.2. They include commercial merchant shipping and other vessel-related activities, recreational water activities (as a result of the potential for ship/boat collisions and noise from ship/boat engines); noise from aircraft operations, and research activities. As noted in Section 3.3.1.3, by most recent counts, it appears that the Hawaiian monk seal population is declining at about 5%/year (Nitta, pers. comm., 1995). The discussion below also accounts for MMRP-related activities: 1) aerial visuall suverys/observations, 2) shipboard acoustic surveys/observations.

• Merchant shipping and other vessel-related activities: Few authors have described responses of pinnipeds to boats or ships; again, most of the published reports are anecdotal in nature.

Northern fur seals reportedly are quite tame when first encountered by a ship, but will avoid the vessel if it engages in seal hunting for a day or more in the same area (Kajimura in Johnson et al., 1989). Kajimura suspected that, once sensitized in this way, fur seals showed repeat avoidances at distances as great as 1.8 km. California sea lions tolerate close and frequent approaches by vessels in shipping lanes, and sometimes congregate around fishing boats (Bigg and Burns in Johnson et al., 1989).

Few authors have described responses of pinnipeds to boats or ships; most of the published reports are anecdotal in nature. In California, small boats that approach harbor seals within about 100 m frequently cause them to depart their haul-out sites; less severe disturbances often cause alert reactions without leaving (Bowles and Stewart, 1980; Allen et al., 1984; Osborn, 1985). In some places where there are many boats, harbor seals apparently habituate (Johnson et al., 1989). In England, some harbor seals, as well as gray seals, permit close approach by tour boats that repeatedly visit seal haul-out locations (Bonner, 1982), suggesting that the animals habituate to sounds from these specific tour vessels.

There are no published details on collisions between monk seals and ships, boats, or thrillcraft in the northern Kauai offshore area. However, it is expected that these incidents may occur from time to time.

• Aircraft operations: There has been little systematic study of the reactions of pinnipeds to aircraft overflights, but many opportunistic, anecdotal reports are available for pinnipeds hauled out on land or ice. In general, pinnipeds hauled out for pupping or molting appear to be the most susceptible to adverse effects resulting from disturbance by airplanes (Bowles and Stewart, 1980). The strongest reactions (e.g., rushing into the water, in severe cases resulting in abandonment and mortality of pups) appear to be elicited by low-flying aircraft, aircraft that are nearly overhead, aircraft exhibiting abruptly changing sounds, and helicopters versus fixed-wing aircraft (Salter, 1979). There is some evidence that they react more strongly to helicopters than fixed-wing aircraft (Johnson, 1977), but the lack of measured sound levels in these instances make this postulation uncertain.

• Research activities: The discussion in Section 4.3.1.1.2 of the potential for and, consequences of, ongoing and future research activities in the vicinity of the study area on mysticetes, is relevant to the Hawaiian monk seal, as well.

Appendix C describes the MMRP aerial and vessel activities and schedules that would be performed as part of the proposed research protocol.

As with mysticetes and odontocetes, any cumulative impacts on pinnipeds from other sources of subsea sounds or developments that affect the marine environment in the vicinity of the proposed project are speculative. Given that the zone of audibility for the Hawaiian monk seal is >100 dB, considering their low densities, and in light of the lack of direct impacts, cumulative impacts are not anticipated.

4.3.1.3.3 Summary and Conclusions Concerning the Potential Effects on Pinnipeds

This section summarizes the information presented in the previous sections regarding potential effect of the proposed source operations and MMRP on pinnipeds.

The Hawaiian monk seal likely has poor low frequency hearing abilities (hearing threshold estimated at >100 dB at 75 Hz). Also, inasmuch as their primary habitat is the small islands and atolls of the northwest portion of the Hawaiian Archipelago (NMFS, 1993), the potential for exposure to a 120 dB received level (at 2-8% duty cycle) is low. A recent field measurement of Hawaiian monk seal diving depth indicated one dove to at least 500 m. At this depth, an animal could be exposed to received levels of approximately 144 dB from ATOC source transmissions. However, based on the assumptions for incurring TTS, a level of 180 dB would be required, leaving a 36 dB safety buffer for the rare instance when a monk seal may be at such a deep depth directly over the ATOC source, during its 2-8% duty cycle on period.

Generally, the impacts are expected to be the same or somewhat less at the Johnston Atoll site, given that the potential for monk seal habitation there is less than for the area off the north shore of Kauai. The autonomous source alternative would be expected to have minimal impacts on Hawaiian monk seals because none would be exposed to transmissions originating in the open ocean.

Table 4.3.1.3.3-1 summarizes the potential for direct and indirect, and cumulative effects on the one pinniped found in Hawaiian waters, the Hawaiian monk seal.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS)	Assumptions: • Hawaiian monk seal is the only pinniped to inhabit the Hawaiian Islands and rarely occurs in the Kauai area. • Pinniped hearing sensitivity good at high frequencies. • Underwater audiograms on several pinniped species (phocids--harbor, ringed, harp, monk seals; otariids--California sea lions, northern fur seals) suggest low audiometric and behavioral sensitivity to low frequency sounds. • Monk seal hearing threshold estimated to be >100 dB at 75 Hz. • Monk seal max diving depth ≥ 500 m • For TTS or PTS to occur, animal would be capable of hearing signals below 90 Hz, have hearing sensitivity below (better than) 70 dB for frequencies <90 Hz (assuming TTS at received levels ≥80 dB above absolute threshold). *Very Low, provided assumptions are correct.*	Assumptions: • No physical auditory effects on pinnipeds. *None*	Assumptions: • Alternative 1 assumptions valid. • Assume sound fields and duty cycles comparable to Kauai. • Monk seal appearances are even rarer at Johnston Atoll. *Very Low, provided assumptions are correct.*	Assumptions: • Pinniped hearing sensitivity good at high frequencies. • Underwater audiograms on several pinnipeds (phocids--harbor, ringed, harp, monk seals; otariids--California sea lions, northern fur seals) suggest low audiometric and behavioral sensitivity to low frequency sounds. • Monk seal hearing threshold estimated to be >100 dB at 75 Hz. • Cannot assume sound fields would be comparable to Kauai or Johnston Atoll because of probable source characteristic differences. • Probably a lower density of pinnipeds could be expected in selected deep-water sites. However, differences in sound fields for this site (compared to Kauai and/or Johnston Atoll) could offset the benefit of potentially fewer pinnipeds. *Uncertain, but presumed very low, provided assumptions are correct.*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Behavioral disruption and Habituation	Assumptions: • Sound fields: - 120 dB 12 km shoreward, 7.5 km seaward from source. - 130 dB 5 km around source. - 135 dB 1000 m around source. - 140 dB at 288 m depth (562 m range around source). - 145 dB at 534 m depth (316 m range around source) - 150 dB at 672 m depth (178 m range around source. - 165 dB at 820 m depth (30 m range around source) - 195 dB at 850 m depth (1 m range around source). • Duty cycles 2%-8%. • Available data indicate Hawaiian monk seal unresponsive to LF noise. •Very few Hawaiian monk seals expected in proposed study area. • Wide variations in sensitivity to human-made noise between and within pinniped species, due to physical and/or biological factors. *Very Low, provided assumptions are correct.*	Assumptions: • No potential behavioral disruption or habituation. *None*	Assumptions: • Sound fields and duty cycles comparable to Kauai alternative. • Available data indicate pinnipeds to be unresponsive to low frequency noise. • Very few Hawaiian monk seals expected in proposed study area. Number of animals present in area on an annual basis is unknown. • Wide variations in sensitivity to human-made noise between and within pinniped species, due to physical and/or biological factors. *Very Low, provided assumptions are correct.*	Assumptions: • Available data indicate pinnipeds to be unresponsive to low frequency noise. • Wide variations in sensitivity to human-made noise between and within pinniped species, due to physical and/or biological factors. • Cannot assume sound fields would be comparable to Kauai or Johnston Atoll because of probable source characteristic differences. • Probably a lower density of pinnipeds could be expected in selected deep-water sites. However, differences in sound fields for this site (compared to Kauai and/or Johnston Atoll) could offset the benefit of potentially fewer pinnipeds. *Uncertain, but presumed very low, provided assumptions are correct.*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Monk seals not expected to be disturbed, given poor low frequency hearing capability and low densities of animals in study area.	Assumptions: • No long-term effects.	Assumptions: • Repeated disturbance could result in medium- or long-term displacement of animals. • Number of pinnipeds sighted annually in area unknown. • Assume sound field characteristics and duty cycles comparable to Kauai alternative. • Monk seals not expected to be disturbed, given poor low frequency hearing capability and low densities of animals in study area.	Assumptions: • Repeated disturbance could result in medium- or long-term displacement of animals. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably lower density of pinnipeds could be expected in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer pinnipeds.
	Uncertain, but presumed None, provided assumptions are correct.	*None*	*Uncertain, but presumed None, provided assumptions are correct.*	*Unknown*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Masking	Assumptions: • Sound fields and duty cycles as described above. • Hawaiian monk seal underwater audiogram indicates best hearing sensitivity between 12 and 28 kHz, and that below 8 kHz hearing is less sensitive than any other pinnipeds tested. • Very few Hawaiian monk seals expected in proposed study area. *Very Low, provided assumptions are correct.*	Assumptions: • No increase in masking. *None*	Assumptions: • Sound fields and duty cycles as described above. • Hawaiian monk seal underwater audiogram indicates best hearing sensitivity between 12 and 28 kHz, and that below 8 kHz hearing is less sensitive than other pinnipeds tested. • Very few Hawaiian monk seals expected in proposed study area. Number of sightings annually is unknown *Very Low, provided assumptions are correct.*	Assumptions: • Hawaiian monk seal underwater audiogram indicates best hearing sensitivity between 12 and 28 kHz, and that below 8 kHz hearing is less sensitive than other pinnipeds tested. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably lower density of pinnipeds could be expected in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer pinnipeds. *Unknown*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect pinnipeds. • Hawaiian monk seal feeds primarily on benthic and reef-dwelling fish, and invertebrates, including flatfish, scorpenids, eels, octopuses, and spiny lobsters. If low frequency sounds were to affect any of these species, depending on the extent to which their availability might be altered, there could be negative consequences to monk seal population that feeds on them. • Very few Hawaiian monk seals expected in proposed study area. • Acoustic transmissions from north Kauai seabed should have negligible, if any, affect on primary food species of Hawaiian monk seal. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • No indirect effects. *None*	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect odontocetes. • Hawaiian monk seal feeds primarily on benthic and reef-dwelling fish, and invertebrates, including flatfish, scorpenids, eels, octopuses, and spiny lobsters. If low frequency sounds were to affect any of these species, depending on the extent to which their availability might be altered, there could be negative consequences to monk seal population. • Very few Hawaiian monk seals expected in proposed study area; number of sightings annually unknown. • Acoustic transmissions from north Johnston Atoll seabed should have little, if any, affect on primary food species of Hawaiian monk seal. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect odontocetes. • Because deep-water sites are unknown, pinniped species types that might be affected, and their associated prey species are also unknown. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of probable source characteristic differences. • Probably lower density of pinniped prey species could be expected in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset the benefit of potentially fewer pinniped prey species. *Unknown*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. • Recreational water activities. • Marine and nearshore construction and resort operations. • Aircraft operations • Research activities	Assumptions: • Available data indicate Hawaiian monk seals unresponsive to low frequency noise. • Pinnipeds generally tolerant of vessels; sensitivity to aircraft varies greatly among and within species. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • No cumulative effects. *None*	Assumptions: • Pinniped population and movement patterns around Johnston Atoll have not been studied. • Available data indicate Hawaiian monk seals unresponsive to low frequency noise. • Pinnipeds generally tolerant of vessels; sensitivity to aircraft varies greatly among and within species. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • Pinniped population and movement patterns around potential moored autonomous source sites is unknown. • Probably lower density of pinnipeds in deep-water area. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset benefit of fewer pinnipeds • Cannot assume sound field characteristics comparable because of probable source characteristic differences. *Unknown*

Note: Hawaiian monk seal only pinniped inhabitant of Hawaiian Archipelago.
Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.1.3.3-1. Potential direct and indirect, and cumulative effects on pinnipeds.

4.3.2 OTHER MARINE SPECIES

Although potential effects of low frequency sounds on marine mammals have been the principal area of concern, other marine species might also be affected by the proposed MMRP and acoustic source transmissions. These include sea turtles (such as green, loggerhead, olive ridley, leatherback, and hawksbill); fish (including demersal, pelagic, and shark); invertebrates (including cephalopod and crustacean); coral and algae; plankton; and seabirds (particularly those that are known to dive deeply). With regard to many of these species, evidence concerning hearing ability and the response to low frequency sound is even less known than is the case for marine mammals. This section of the EIS, however, summarizes the knowledge available about these species and discusses the potential direct, indirect and cumulative impacts of the alternatives.

4.3.2.1 Sea Turtles

As discussed in Section 3, the most frequently sighted sea turtle off north Kauai is the green turtle. Other sea turtles are less common, but some of those species are relatively good divers that could approach, but likely not reach, proximity to the source. This subsection presents the available scientific information concerning the hearing abilities of these animals, together with a discussion of their diving abilities and resulting potential impacts on sea turtles.

Since sea turtles, especially leatherbacks, are one of the prey species for killer whales, and some sharks, the following discussions of the potential direct, indirect, and cumulative impacts of the proposed project on sea turtles, is also a discussion of the indirect impacts on killer whales and sharks.

4.3.2.1.1 <u>Potential Direct and Indirect Effects on Sea Turtles</u>

Section 3 discusses the species of sea turtles that have been sighted in or near the proposed study area. The maximum residence time within the area of the proposed action alternative for sea turtles is estimated to be <24 hrs. This is based on the limited population data available for the Hawaiian Island/mid-Pacific area, coupled with the expected average transit speeds for sea turtles (0.65 m/sec for leatherbacks; approximately 1 m/sec for loggerheads and olive ridleys) (Eckert, pers. comm., 1994). These estimates apply primarily to leatherbacks, loggerheads and olive ridleys that would be most likely to pass through the sound fields located relatively far offshore. Green turtles spend most of their time associated with coastal features after taking up residence at foraging pastures, although satellite tagging studies indicate a migratory pathway north of Kauai for some of the turtles tagged at French Frigate Shoals (see Section 3.3.2).

As noted previously, transmissions from the proposed sound source would generate a received level of 136 dB at 1000 m radius, directly above the source itself (received level is not expected to exceed 135 dB at the surface anywhere in the vicinity of the source). Other received level values would be: 130 dB to a radius of 5 km; 120 dB to 12 km shoreward and 7.5 km seaward from the source; and 110 dB to 55 km seaward. Below the surface, sound levels are expected to be: 140 dB at 288 m depth (562 m range around the source); 145 dB at 534 m depth (316 m range around the source); 150 dB at 672 m depth (178 m range around the source); 165 dB at 820 m depth (30 m range around the source); and 195 dB at 850 m depth (1 m range around source). See Figures 2.2.1.2-3 and 2.2.1.2-4.

Potential direct and indirect effects of low frequency sound on sea turtles such as physical auditory effects, behavioral disruption, long-term effects, masking, and adverse impacts on their food chain (indirect effects) are discussed below.

• Hearing capabilities of sea turtles: Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized tympanum (eardrum). Instead, they have a cutaneous layer and underlying subcutaneous fatty layer, that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extracolumella, a cartilaginous disk, located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al., 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull. Low frequency sounds at high source levels also can be detected by vibration-sensitive touch receptors in various other parts of the turtle's body (Bowles, pers. comm., 1994).

Sea turtle auditory sensitivity is not well studied, though a few preliminary investigations suggest that it is limited to low frequency bandwidths, such as the sounds of waves breaking on a beach. The role of underwater low frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983).

The few studies completed on the auditory capabilities of sea turtles suggest that they could be capable of hearing low frequency sounds. These investigations have used adult green, loggerhead, and Kemp's ridley (*Lepidochelys kempii*) in their research protocol. The authors are aware of no studies to date of olive ridley, hawksbill, or leatherback. The MMRP would support field research to obtain auditory and/or behavioral observations on leatherbacks.

Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green 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. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing threshold was about 64 dB in air (approximately 126 dB in water). At 70 Hz, it was about 70 dB in air (approximately 132 dB in water). This has led Eckert (pers. comm., 1994) to conclude that green turtles could possibly hear the source transmissions if they were located in the sound field corresponding to 132 dB received level (<3 km radius around the source site) during one of the transmission periods. Ridgway (pers. comm., 1994) doubts that the 75 Hz, 195 dB source at 850 m depth could be a direct cause of injury to green turtles, but that the potential for behavioral disruption (e.g., migration orientation) is less certain (Balazs, pers. comm., 1995).

Lenhardt et al. (1983) applied audiofrequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever, 1978). 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.

More recently, Lenhardt (1994) used a water-coupled speaker and accelerometers to determine the behavioral effects of low frequency sounds (20-80 Hz, 175-180 dB) on captive loggerheads held in a 1 m deep circular tank. Turtles responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions.

There are no underwater audiogram data available for leatherbacks. Because they are *morphologically distinct (leathery shell, with minimal calcification of bone), approximating* hearing thresholds from data available for the other (hard shell) species is probably inappropriate. There is anecdotal information that a leatherback in the wild appeared to exhibit changes in its behavior in response to the sound of a boat motor, transmitted at an estimated 160 dB, from a distance of 10-15 km from the turtle. This observation suggests that leatherbacks may be sensitive to low frequency sounds, but the response could have been to mid or high frequency components of the sound (Eckert, pers. comm., 1994).

• Potential for physical auditory effects: Of the five species of sea turtle that may occur off the north Kauai coast, only the dive depth capabilities of the leatherback have been investigated. An olive ridley once was observed at a depth of 300 m (Landis, 1965, reported in Eckert et al., 1989), but there are no other published data available on observed dive depth capabilities of this species, greens, loggerheads, or hawksbills. Berkson (1967) addressed physiological adjustments to deep diving in the Pacific green turtle, but his work was based on laboratory study.

The leatherback is the only species known to be capable of diving deep enough to enter the 150 dB sound field around the source (where it is suspected that a temporary threshold shift could possibly occur). The deepest dive recorded for a leatherback was approximately 1300 m (Eckert et al., 1989). However, the average dive depth recorded for six females during their internesting period was only 61.6 m (Eckert et al., 1989). Some sea turtles exhibit a noticeably different diving behavior during the internesting period, as compared to the postnesting period, because they are gravid, and tend to be less active during this time (Plotkin, pers. comm., 1994). If this is also true for leatherbacks, then internesting dive behavior may not accurately reflect their postnesting dive behavior. Eckert (pers. comm., 1994) noted that time-depth-recorder (TDR) satellite tracking data obtained from two leatherbacks indicated that all dives >400 m depth were made subsequent to the nesting season and represented only 0.6% of all dives. The leatherback spends most of its dive time traveling to and from maximum depth; typical times spent at maximum depth are on the order of 2-4 min. This information is based on data from

TDRs deployed on six leatherbacks (Eckert et al., 1989). Even though this animal has been known to dive as deep as 1300 m, and these deep dives are probably important evolutions, it is not considered a bottom-feeder, and does not usually forage, nor find refuge on the bottom., but rather it appears to forage in the water column, possibly tracking the deep scattering layer (Eckert, pers. comm., 1994).

Extrapolation from human and marine mammal data to turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. However, as stated above, the measured hearing threshold for green turtles (and by extrapolation, at least the olive ridley, loggerhead, and hawksbill) is only slightly lower than the maximum levels to which these three species could be exposed. It is not believed that a temporary threshold shift would occur at such a small margin over threshold in any species. Therefore, no threshold shifts in green, olive ridley, loggerhead, or hawksbill sea turtles are expected.

Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown. Moreover, only generalized information is available concerning the distribution of leatherbacks, but they are known to be present in the project area, they tend to prefer continental slope areas, and they can dive deeply. Therefore, despite the lack of direct information, it is presumed that leatherbacks are capable of being exposed to sound levels that could cause temporary threshold shift. However, inasmuch as the density of leatherbacks over the study area is low, but patchy (Eckert, pers. comm., 1994), the fact that only a small percentage of time is spent at depth, the intermittent nature and low duty cycle of the ATOC source, and the fact that the proposed project site is not believed to be a particularly important location of leatherback prey species, any impact should be minimal.

Mitigation Measure 8-1: The MMRP would support field research to attempt the collection of auditory and/or behavioral observations on leatherback sea turtles.

• Potential for behavioral disruption: Based on the conclusions of Lenhardt et al. (1983), and O'Hara and Wilcox (1990), low frequency acoustic sound transmissions at source levels of 141-150 dB could potentially cause increased surfacing behavior and deterrence from the area near the sound source. The potential for increased surfacing behavior could place turtles at greater risk from vessel collision and potentially greater vulnerability to natural predators. Deterrence from the area could result in temporary or permanent displacement of individuals. To encounter received levels of 140 dB, a turtle would have to dive to depths greater than 300 m, and be located inside the 140 dB isopleth (equating to 0.372 km^3 volume around source), not depart the area during the 5-min ramp-up period, and remain there during the source transmission, which has a maximum duty cycle of 8%.

Thus the potential for short-term behavioral disruption or displacement on sea turtles is considered unlikely, although sound transmissions with received levels ≥132 dB could possibly be audible to animals within 3 km of the source. Potential effects on the deep-diving leatherback are more uncertain.

Mitigation Measure 9-1: The MMRP would incorporate into its research protocol the goal of assessing whether acoustic transmissions could potentially cause sea turtles to spend more time than normal at the sea surface.

Mitigation Measure 9-2: The MMRP would incorporate into its research protocol the goal of assessing whether acoustic transmissions could potentially cause leatherbacks and other sea turtle species to avoid the ATOC source area.

• Potential for long-term effects: Discussion of the potential for and, ramifications of, long-term effects with respect to mysticetes, odontocetes and pinnipeds is relevant to sea turtles, as well. In light of the available data (both measured and anecdotal) on sea turtles' audiometric sensitivity to low frequency sound, it is believed that the potential for long-term effects on sea turtles is believed to be minimal, with the possible exception of leatherbacks.

• Potential for Masking: Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time; anecdotal information suggests that the acoustic signature of a turtle's natal beach might serve as a cue for nesting returns. However, the concept of sound masking is difficult, if not impossible, to apply to sea turtles.

Although low frequency hearing has not been studied in many sea turtle species, those that have been tested, for the most part, exhibit low audiometric and behavioral sensitivity to low frequency sound. Thus, for sounds dominated by low frequency components, the maximum radius of audibility for most sea turtles may often be determined by their hearing sensitivity, rather than the background noise level. It appears, therefore, that if there were the potential for the proposed sound transmissions to increase masking effects of any sea turtle species, it would be expected to be minimal, with the possible exception of leatherbacks.

Moreover, any sounds that the proposed source might mask are not expected to be particularly significant from the standpoint of turtles. The relatively short transmissions and low duty cycle of the source means that it would mask sounds only for brief periods; sounds longer than this would not be completely masked (such as a ship approaching from a distance). Many sounds of concern (including ship noise which can be a signal of a collision hazard) are broad spectrum signals with components in the frequency range that turtles are known to hear; the ATOC source's narrow bandwidth, low frequency transmissions would not completely mask these sounds. If the ATOC source would create masking effects, existing ship traffic already would be creating masking effects to a much greater degree (ship sounds are much higher surface sound levels than the proposed source); there is no evidence of a significant effect from current noise sources, but it must be recognized that such effects would be exceedingly difficult to observe. Given the lack of direct evidence, it is presumed that masking effects on sea turtles may occur, but it is anticipated any effects would be minor.

• Potential for indirect effects: Indirect effects include those effects that could be caused by the proposed action and are later in time, or farther removed in distance, but would still be reasonably foreseeable. The principal indirect effect in this case would be the potential impact on the food chain that could ultimately affect any of the species of sea turtle in the vicinity of the study area. The following lists the common prey species for the sea turtles that could be expected in the study area (Márquez, 1990):

- Leatherback sea turtle: cnidarians (gelatinous zooplankton), tunicates (filter feeders), and jellyfish.

- Green sea turtle: none during neritic phase (food items include coastal algae and seagrasses); during pelagic phase they are carnivorous and feed on various invertebrates (jellyfish, etc.).

- Loggerhead sea turtle: juveniles and subadults are omnivorous (pelagic crabs, mollusks, and jellyfish) (other food items include near-surface/surface vegetation); adults are generalist carnivores (nearshore benthic [seafloor] invertebrates).

- Olive ridley sea turtle: salps, pelagic crustaceans, and other invertebrates.

- Hawksbill: corals, tunicates, sponges (food items include algae).

If low frequency sound transmissions were to affect any of these prey species, depending on the extent to which their availability might be altered, there could be negative consequences to the sea turtle population off the north Kauai coast.

Sections 4.3.2.3 and 4.3.2.4 contain discussions of the potential direct, indirect, and cumulative impacts of the proposed project on squid, crabs, mollusks, jellyfish and other invertebrates and zooplankton which are prey species for sea turtles. Those sections constitute the discussion of the indirect impacts on sea turtle species that could occur in the project vicinity. The proposed project will have no impact on coastal algae and seagrasses that green turtles feed on, and there are, therefore, no indirect impacts expected on that species. The proposed source site is not known to be a significant feeding area for any sea turtle species, and any potential effects on prey species would be incremental and affect only a small portion of the range. To further assess the potential for indirect impacts, the MMRP would include observations of the potential impact of source operations on prey species, as discussed and identified as a mitigation measure in corresponding sections below.

4.3.2.1.2 Potential Cumulative Effects on Sea Turtles

Activities that potentially could be considered to interact in a cumulative sense on sea turtle species that might inhabit or travel through the proposed study area include: 1) merchant shipping and other vessel-related activities, and recreational water activities (as a result of the potential for vessel collisions); and 2) aircraft operations. The discussions below also account for MMRP-related activities that could potentially cumulate with the source transmissions; 1)aerial visual surveys/observations, 2) shipboard acoustic surveys/observations.

• Merchant shipping and other vessel-related activities: There are no published details on collisions between sea turtles and ships, boats, or thrillcraft in the north Kauai area. In fact, very few authors have described responses of sea turtles to ships or boats; with most of these being anecdotal in nature. However, it is expected that such incidents do occur from time to time, particularly since these species do spend time close to the coast, where fishing and pleasure boating is most prevalent.

The potential concern in this case would be that, if sea turtles were able to hear the acoustic signal, it could possibly cause them to modify their natural behavior and spend more time at the surface where they would be more susceptible to predators and collisions with vessels. Based on one of the few calibrated experiments to determine auditory capability in sea turtles, in-air data has been extrapolated to derive a green turtle's hearing threshold (in water) at 132 dB at 70 Hz. Using this value as a benchmark, the potential for a sea turtle to be influenced by a source transmission can at least be bounded to some extent. In this case, for the turtle to be exposed to sound levels ≥132 dB, it would have to be within 3 km of the source location at the sea surface, or to be exposed to sound levels >138 dB, it would have to be located deeper than 150 m and within 700 m range from the source proper. Added to these positional criteria are the facts that the maximum 'on' period for the source would be only 8% of the time (usually only 2%), and that there would always be a 5-min ramp-up period leading up to full power operation, so that if the animal did hear the sound, and found it annoying, it could swim away. Thus, it appears that the potential for source noise to affect the behavior of a sea turtle, such that it would be placed in greater peril at the surface from collisions with merchant shipping and other vessel-related activities, or to greater predation, is possible, but probably minimal. As these findings are based on the aforementioned extrapolation, if the assumptions are incorrect (i.e., hearing thresholds are lower), a proportional increase in the radius of audibility would result.

• Aircraft operations: There have been no systematic studies of the reactions of sea turtles to aircraft overflights and even anecdotal reports are scarce. Balazs and Ross (1974) dealt with the effect of aircraft noise on sea turtles in terrestrial habitat. It seems reasonable to expect that noise from aircraft, both fixed- and rotary-wing, could be heard by a sea turtle at or near the surface, and cause it to alter its normal behavior pattern. Any potential change in cumulative effect of aircraft noise in the study area due to the addition of MMRP activities and sound transmissions is unknown, although presumed to be very minimal. The potential change in cumulative effect due to the addition of MMRP aerial survey flights (maximum 4 flights per week; usually 1-2) must be stated as unknown, but is expected to be minimal.

Appendix C describes in detail the planned aerial and vessel protocols for the proposed MMRP research efforts in support of this project.

As with the other marine species, any cumulative impacts on sea turtles from other sources of subsea sounds are speculative.

4.3.2.1.3 Summary and Conclusions Concerning the Potential Effects on Sea Turtles

This section summarizes the information presented in the previous sections regarding potential effects of the proposed source operations and MMRP on sea turtles.

Leatherbacks represent the only species that are known to have the capability to dive deep and may possess some measure of low frequency hearing capability, the combination of which presents the possibility that a very small number potentially could be at risk due to the ATOC sound transmissions, over the course of a two-year period. Leatherbacks have been known to dive to depths of 1300 m, but most dives are more shallow, following the deep scattering layer, from which they feed on squid and plankton. They make extensive seasonal migrations from their nesting sites in Baja California to Alaska, seeming to follow the water temperature contours (usually the 16°C isotherm). They do not nest regularly in the Hawaiian Islands, and their sightings near the Hawaiian Archipelago, although relatively common, usually occur in deep oceanic waters (>1000 m depth). Although little is known about leatherback hearing, they may be sensitive to low frequency sound. It is therefore possible that they might exhibit some behavioral disturbance if they are close enough to the sound source during transmissions. However, given the presumed low density of this species for the study area (based on limited data), the infrequency of deep dives, the 5-min source ramp-up period, and their ability to swim to beyond the 150 dB sound field, it is believed that very few, if any, leatherbacks would be expected to be exposed to ATOC sound transmissions at levels high enough to have the potential to cause TTS.

Potential impacts on leatherback sea turtles should be more or less the same for the Johnston Atoll site, and might be slightly greater at any deep-water automous source site because that species prefers deep water over the continental slope. Not enough is known about sea turtle migration paths and distribution ranges to analyze any other differences among the alternatives, although the "no action" alternative would have no impacts.

Table 4.3.2.1.3-1 summarizes the potential direct and indirect effects, and potential cumulative effects of the alternatives on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS)	Assumptions: • Sea turtle hearing sensitivity not well studied; role of underwater low frequency sound unclear. • The few studies on sea turtles suggest potential capability of low frequency (<1000 Hz) hearing; green turtles probably hear best in 200-700 Hz band. • No audiogram data on leatherbacks; because of morphological differences, cannot extrapolate hard-shell turtle data to leatherbacks. • Leatherback only species known to be capable of diving deep enough to enter 150 dB sound field, but most dives are <400 m. • Leatherbacks do not nest regularly in Hawaiian Islands: their sightings, although relatively common, usually occur in deep oceanic waters. *Low for all but leatherback; provided assumptions are correct. Uncertain for leatherback, but presumed Low, provided assumptions are correct.*	Assumptions: • No physical auditory effects. *None*	Assumptions: • Sea turtle hearing sensitivity not well studied; role of underwater low frequency sound unclear. • The few studies on sea turtles suggest potential capability of low frequency (<1000 Hz) hearing; green turtles probably hear best in 200-700 Hz band. • No audiogram data on leatherbacks; because of morphological differences, cannot extrapolate hard-shell turtle data to leatherbacks. • Leatherback only species known to be capable of diving deep enough to enter 150 dB sound field, but most dives are <400 m. • Leatherbacks do not nest regularly on Johnston Atoll; their sightings, although relatively common, usually occur in deep oceanic waters. *Low for all but leatherback; provided assumptions are correct. Uncertain for leatherback, but presumed Low, provided assumptions are correct.*	Assumptions: • Sea turtle hearing sensitivity not well studied; role of underwater low frequency sound unclear. • The few studies on sea turtles suggest capability of low frequency hearing (<1000 Hz); green turtles probably hear best in 200-700 Hz band. • No audiogram data on leatherbacks; because of morphological differences, cannot extrapolate hard-shell turtle data to leatherbacks. • Leatherback only species known to be capable of diving deep enough to enter 150 dB sound field, but most dives are <400 m. • Cannot assume sound fields would be same as Kauai or Johnston Atoll because of probable source characteristic differences. • Potential impact on leatherbacks might be slightly greater because that species prefers deep oceanic water over continental slope. *Unknown*

Note: Relative level of impact/effect *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Behavioral disruption and Habituation	Assumptions: • Sound fields: - 120 dB 12 km shoreward, 7.5 km seaward from source. - 130 dB 5 km around source. - 135 dB 1000 m around source. - 140 dB at 288 m depth (562 m range around source). - 145 dB at 534 m depth (316 m range around source). - 140 dB at 672 m depth (178 m range around source). - 195 dB at 850 m depth (1 m range around source). • Duty cycles 2% - 8%. • Very limited information suggests that low frequency (<1000 Hz) received levels >141 dB could possibly cause increased surfacing behavior and deterrence from the noise source, which could potentially put turtles at greater risk from vessel collision and vulnerability to predators. • To encounter received levels >141 dB, turtle must dive >300 m, be within 0.372 cu km volume during 2-8% of time source on. Only species believed capable of this is leatherback. • Animals probably would tolerate noise levels ≤136 dB at surface at 2-8% duty cycles.	Assumptions: • No potential behavioral disruption or habituation.	Assumptions: • Sound fields and duty cycles comparable to Kauai alternative. • Other assumptions same as for Kauai.	Assumptions: • Cannot assume sound fields would be same as Kauai or Johnston Atoll because of probable source characteristic differences. • Very limited information suggests that low frequency (<1000 Hz) received levels >141 dB could possibly cause increased surfacing behavior and deterrence from the noise source, which could potentially put turtles at greater risk from vessel collision and vulnerability to predators. • Potential impact on leatherbacks might be slightly greater because that species prefers deep oceanic water over continental slope.
	Low for all but leatherback; provided assumptions are correct. Uncertain for leatherback, but presumed Low, provided assumptions are correct.	*None*	*Low for all but leatherback; provided assumptions are correct. Uncertain for leatherback, but presumed Low, provided assumptions are correct.*	*Unknown*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate initiate negative energetic consequences for individual sea turtles are unknown. • Potential for stress from noise exposure to sound levels ≥136 dB at surface near sound source and higher at typical dive depths, at 2-8% duty cycles uncertain. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • No long-term effects. *None*	Assumptions: • Assume sound field characteristics and duty cycles comparable to Kauai alternative. • Number of sea turtles sighted annually around Johnston Atoll is unknown. • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate initiate negative energetic consequences for individual sea turtles are unknown. • Potential for stress from noise exposure to sound levels ≤136 dB at surface near sound source and higher at typical dive depths, at 2-8% duty cycles uncertain. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate initiate negative energetic consequences for individual sea turtles are unknown. • Cannot assume sound fields would be same as Kauai or Johnston Atoll because of probable source characteristic differences. • Potential impact on leatherbacks might be slightly greater because that species prefers deep oceanic water over continental slope. *Unknown*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Masking	Assumptions: • Sound fields and duty cycles as described above. • Potential role of long-range acoustical perception in sea turtles is unclear--concept of sound masking is difficult, if not impossible, to apply to sea turtles. • Any sounds that ATOC might mask are not expected to be particularly significant to sea turtles. Short transmission period and low duty cycles would cause only brief masking periods. • ATOC's narrow bandwidth would not compete with broad spectrum signals like ship noise.	Assumptions: • No increase in masking.	Assumptions: • Sound fields and duty cycles as described above. • Potential role of long-range acoustical perception in sea turtles is unclear--concept of sound masking is difficult, if not impossible, to apply to sea turtles. • Any sounds that ATOC might mask are not expected to be particularly significant to sea turtles. Short transmission period and low duty cycles would cause only brief masking periods. • ATOC's narrow bandwidth would not compete with broad spectrum signals like ship noise. • Number of annual sightings of sea turtles in vicinity of Johnston Atoll is unknown.	Assumptions: • Potential role of long-range acoustical perception in sea turtles is unclear--concept of sound masking is difficult, if not impossible, to apply to sea turtles. • Any sounds that ATOC might mask are not expected to be particularly significant to sea turtles. Short transmission period and low duty cycles would cause only brief masking periods. • ATOC's narrow bandwidth would not compete with broad spectrum signals like ship noise. • Cannot assume sound fields would be same as Kauai or Johnston Atoll because of probable source characteristic differences. • Potential impact on leatherbacks might be slightly greater because that species prefers deep oceanic water over continental slope.
	None, provided assumptions are correct.	*None*	*None, provided assumptions are correct.*	*Unknown, but presumed None to Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on food chain that could affect sea turtles. • Principal prey items for sea turtles expected in the study area would be cnidarians, tunicates, crabs, mollusks, jellyfish, benthic invertebrates, salps, pelagic crustaceans, corals, and sponges. They also ingest plants such as algae and seagrasses. • If low frequency sounds were to affect any of these species, depending on the extent to which their availability might be altered, there could be negative consequences to the sea turtle population that feeds on them. • ATOC transmissions would have no impact on algae and seagrasses; minimal impact on sea turtle prey species. • ATOC site not known to be a significant feeding area for any sea turtle species--any possible effects on prey species would be incremental and affect small portion of their overall range.	Assumptions: • No indirect effects.	Assumptions: • Source sound fields and duty cycles as described above. • Assumptions 1-4 same as Kauai alternative. • ATOC site not known to be a significant feeding area for any sea turtle species--any possible effects on prey species would be incremental and affect small portion of their overall range.	Assumptions: • Assumptions 1-4 same as Kauai alternative. • Any potential deep sea moored autonomous source site would not be expected to be a significant feeding area for any sea turtle species--any possible effects on prey species would be incremental and affect small portion of their overall range. • Cannot assume sound fields would be same as Kauai or Johnston Atoll because of probable source characteristic differences. • Potential impact on leatherbacks might be slightly greater because that species prefers deep oceanic water over continental slope.
	Uncertain, but presumed None to Low, provided assumptions are correct.	*None*	*Uncertain, but presumed None to Low, provided assumptions are correct.*	*Uncertain, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. • Recreational water activities. • Marine and nearshore construction and resort operations. • Aircraft operations • Research activities	Assumptions: • No published data on collisions between sea turtles and surface vessels in north Kauai area. • Higher proportion of population(s) likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources expected to increase potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if sources emit similar sounds rather than varying characteristics. • Potential for increased time at surface due to increased cumulative effect from addition of ATOC transmissions to local low frequency noise fields would be minimal. • No systematic studies of reactions of sea turtles to aircraft operations--potential increase in cumulative effect due to MMRP flights would be minimal. *Uncertain, but presumed None to Low, provided assumptions are correct.*	Assumptions: • No cumulative effects. *None*	Assumptions: • No published data on collisions between sea turtles and surface vessels in Johnston Atoll area. • Higher proportion of population(s) likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources expected to increase potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if sources emit similar sounds rather than varying characteristics. • Potential for increased time at surface due to increased cumulative effect from addition of ATOC transmissions to local low frequency noise fields would be minimal. • No systematic studies of reactions of sea turtles to aircraft operations--potential increase in cumulative effect due to MMRP flights would be minimal. *Uncertain, but presumed None to Low, provided assumptions are correct.*	Assumptions: • No published data on collisions between sea turtles and surface vessels in North Pacific. • Higher proportion of population(s) likely to be affected; potential for interruption of behavior and possible displacement more frequent as number of sources increases; simultaneous presence of number of noise sources expected to increase potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely to depend on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if sources emit similar sounds rather than varying characteristics. • Potential for increased time at surface due to increased cumulative effect from addition of ATOC transmissions to local low frequency noise fields would be minimal. • No systematic studies of reactions of sea turtles to aircraft operations--potential increase in cumulative effect due to MMRP flights would be minimal. *Uncertain, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown*

Table 4.3.2.1.3-1. Potential direct and indirect, and cumulative effects on sea turtles.

4.3.2.2 Fish

The greatest body of acoustic data have been collected on bony fish, while virtually nothing is known of hearing in jawless fish (Popper and Fay, 1993). This EIS primarily addresses the potential impact on marine fish off the north Kauai coast. Most of the audiometric data collected on fish are for freshwater species. The few data for those fish that do inhabit the study area indicate that their best hearing frequencies do not occur below 100 Hz.

Various species may detect and process sound in different ways, depending on taxonomic, anatomical, behavioral and physiological variations among species (Popper and Coombs, 1982; Popper, 1983; Schellart and Popper, 1992). These differences in species may include:

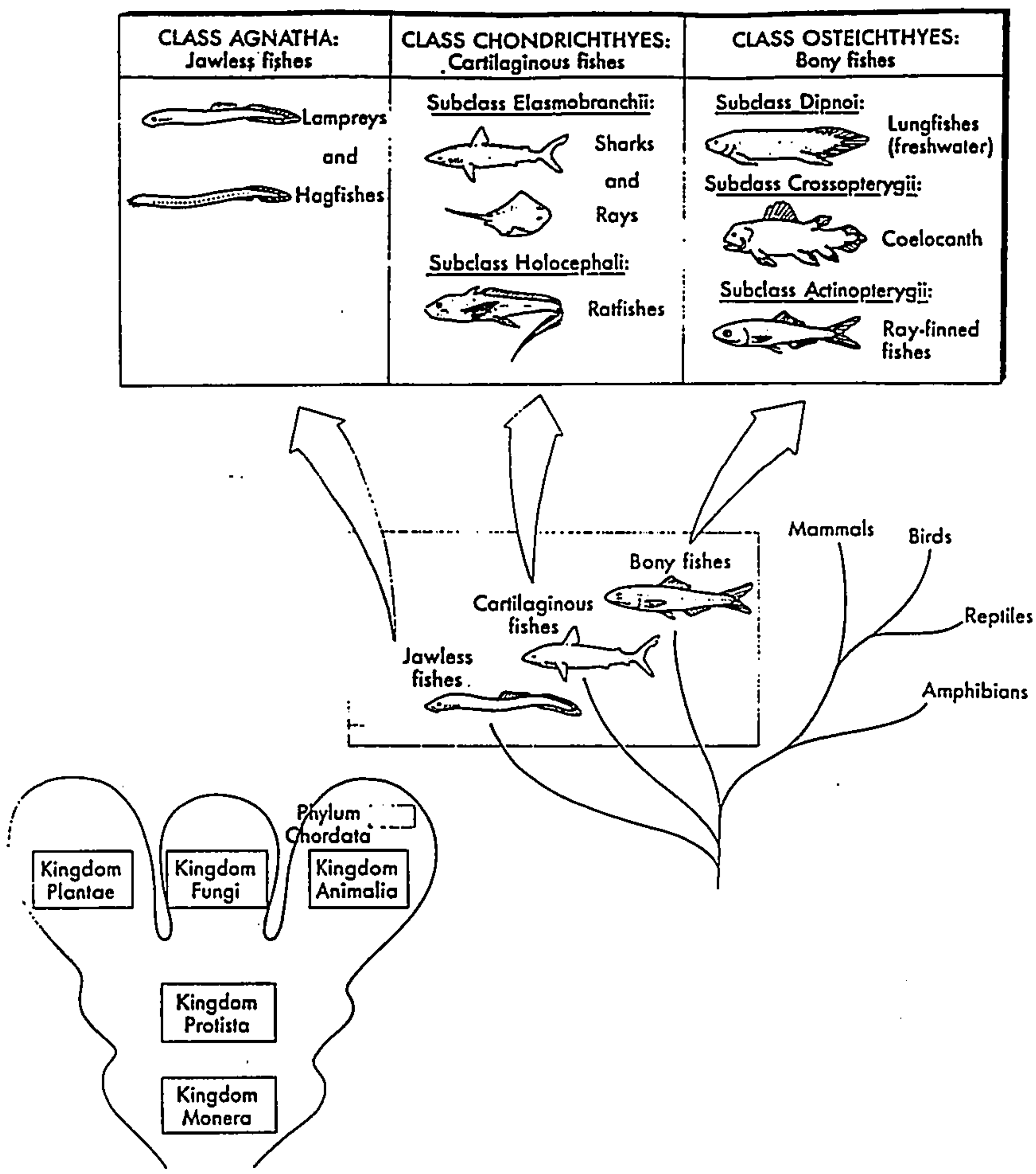
- their peripheral auditory structures,
- the acoustic characteristics of their usual environment, or
- their taxonomic grouping (Figure 4.3.2.2-1).

Most species for which hearing has been studied are teleost fish. Among the teleosts, the species with the best hearing capabilities are members of the series Otophysi. Otophysans represent about 6000 species that include goldfish, carp, minnows, catfish and knifefish. In the otophysans, the gas-filled swimbladder (normally used for buoyancy compensation) is coupled with the inner ears via a series of bones, called the Weberian ossicles. This arrangement is believed to enhance hearing sensitivity and bandwidth (von Frisch, 1938; Dijkgraaf, 1949; Poggendorf, 1952; Kleerekoper and Roggenkamp, 1959). Among all fish species, the otophysans have the best known adaptation for hearing (Popper and Fay, 1993). Thus, the study of this series of animals may provide a relatively conservative estimate for any potential impact of the four alternatives on fish in general. All species without Weberian ossicles are referred to as "non-otophysans." Little information on hearing exists for marine species in the vicinity of the proposed sites. However, data on similar groups of fish may provide relevant comparison.

Many species of fish, particularly rockfish, mackerel, and anchovies, are important prey for marine mammals. Smaller fish are also the prey of larger fish and sharks. Therefore, the following paragraphs also constitute a discussion of potential indirect impacts on odontocetes and pinnipeds, as well as a discussion of the indirect impacts on fish and sharks, which prey on other fish.

4.3.2.2.1 Potential Direct and Indirect Effects on Fish

• Hearing capabilities and sound production of fish: Fish (including otophysans) that have specializations that enhance their hearing sensitivity have been referred to as hearing "specialists;" whereas, those that do not possess such capabilities are termed "nonspecialists." The former tend to have a wider hearing bandwidth and greater sensitivity than the latter. Also, the limited behavioral data available suggest that frequency and intensity discrimination performance may not be as acute in nonspecialists as in specialists (Fay, 1988a).



(From Castro and Huber, 1992)

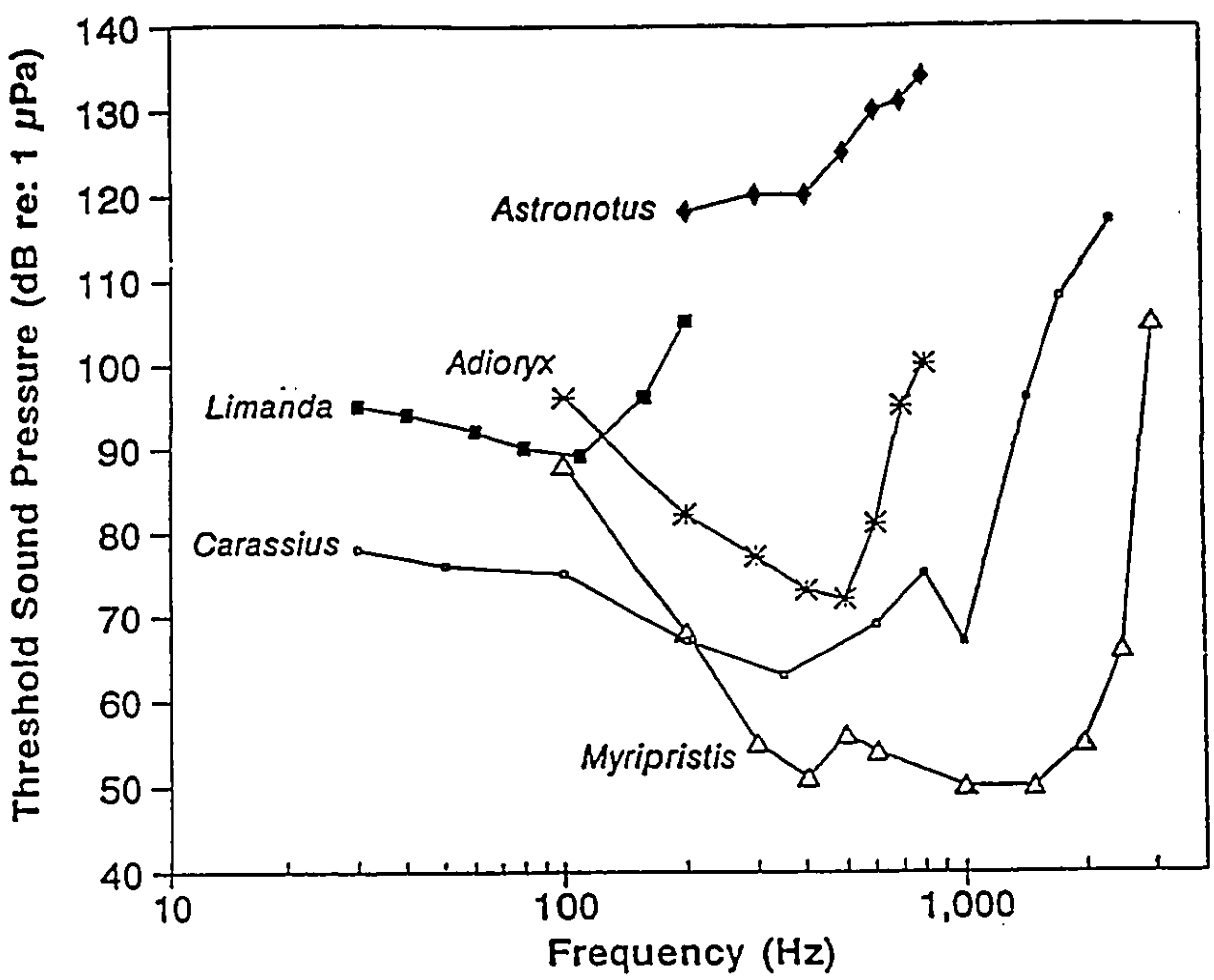
Figure 4.3.2.2-1 Taxonomic classification scheme for fish

Hastings (1990, 1991) presented a good summary of the issues of fish hearing and noted that almost every species of fish has a different auditory system and a different audiogram. She notes that, in general, fish hear sounds in the 50-2000 Hz range, with best sensitivity in the 200-800 Hz bandwidth. In the 100-200 Hz band and below, their lateral system, consisting of tissue containing sensory hair cells (found on the body, head, and in canals on the head and trunk) detects near-field hydrodynamic disturbances. The only reference in the literature to any potential damage to a fish's lateral line system from underwater sound comes from Denton and Gray (1993) wherein their study of clupeids (herrings) suggested that very intense sound stimulation (unquantified) can cause damage to the neuromasts (nerve connection at the base of each sensory organ) of the lateral line.

The primary species of fish expected to inhabit the proposed study area include demersal (bottom-dwelling) and pelagic (water column-dwelling) fish. Based on available audiograms, it appears that, with the exception of sharks, whose best hearing sensitivity is believed to rest between 20 and 300 Hz, local fish should have their best hearing sensitivity in the 200-800 Hz frequency bandwidth.

Myrberg (1980) stated that the most important region of sound detection in most fish is between about 40 and 1000 Hz. Additionally, fish whose hearing sensitivity is in the extremely low register (i.e., 10-500 Hz), including cod and its relatives (e.g., haddock, pollack, lingcod) and toadfish, appear keenly adapted to this particular range of frequencies, possibly because they produce sound in this range (Brawn, 1961; Gray and Winn, 1961; Winn, 1967; Fish and Offutt, 1972). Sharks also have been found to be sensitive to low frequency sounds. For sharks, hearing sensitivity is important for the identification of sounds produced by their prey (Nelson and Gruber, 1963; Myrberg et al., 1976; Nelson and Johnson, 1976; Myrberg, 1978).

Audiograms have been determined for over 50 fish (mostly freshwater) and three shark species (Fay, 1988a). The general pattern from the data indicates that hearing specialists detect sound pressure with greater sensitivity (as low as 55 dB at 400 Hz) and in a wider bandwidth (up to 3 kHz) than the nonspecialists. Figure 4.3.2.2-2 includes behavioral audiograms for two hearing specialists (a goldfish (*Carassius auratus*) and a squirrelfish (*Myripristis kuntee*)), two nonspecialists that have a swimbladder (another squirrelfish (*Adioryx xantherythrus*) and the oscar (*Astronotus ocellatus*)), and one nonspecialist without a swimbladder (lemon sole, *Limanda limanda*). Note that thresholds are expressed as sound pressure levels because that is the measurable quantity (an acoustic particle velocity sensor does not exist for underwater measurements), although this is strictly correct only for the hearing specialists that respond in proportion to sound pressure. In best absolute sensitivity, hearing specialists are similar to most other vertebrates when thresholds determined in water and air are expressed in units of acoustic intensity (i.e., Watts/cm^2) (Popper and Fay, 1973). It is not yet clear whether the thresholds for the nonspecialists should be expressed in terms of sound pressure or particle motion amplitudes. Nevertheless, this potential anomaly would not alter the utility of the estimates, as any errors would only serve to raise the threshold levels of the nonspecialist fish.



Carassius auratus (goldfish; Fay, 1969), and Myripristis kuntee (squirrelfish; Coombs and Popper, 1979); two hearing nonspecialists having a swimbladder, Adioryx xantherythrus (another squirrelfish; Coombs and Popper, 1979), and Astronotus ocellatus (the oscar; Yan and Popper, 1992); and a nonspecialist without a swimbladder, Limanda limanda (lemon sole; Chapman and Sand, 1974).

Figure 4.3.2.2-2 Behavioral audiograms for two "hearing specialists"

As for sound production in fish, Myrberg (1981) stated that more than 50 fish families produce some kind of sound. The context in which sound production occurs varies greatly from species to species. Many examples have been reviewed by Fine et al. (1977) and Myrberg (1981). Myrberg noted that sounds are commonly produced by fish when they are alarmed or presented with noxious stimuli. These responses are usually intense and have a sudden onset, like signals used by both terrestrial and aquatic animals to startle animal receivers (e.g., nearby predators). Sounds also accompany the reproductive activities of numerous fish species, males being the most active producers. Sound activity often accompanies aggressive behavior in fish, usually peaking during the reproductive season. Those benthic fish species that are territorial in nature throughout the year often produce sounds regardless of season, particularly during periods of high-level aggression (Hawkins and Myrberg, 1983). The marine biological scientific community is in agreement that more research into low frequency sound production in fish species needs to be conducted.

Myrberg (1981) believed that fish communicate, or at least attempt to communicate, with different types of receivers; however, direct evidence of such activity is not overwhelming. He goes on to state that most fish sounds are composed predominantly of frequencies below 1 kHz and, accordingly, the animals themselves are most likely sensitive to such frequencies. The fish with the best hearing, the goldfish (*Carassius*) (Popper and Clarke, 1976) had a threshold level between 57.5 and 92.5 Hz of about 78 dB. However, this is a freshwater species, the data for which cannot be compared directly with fish in the ATOC study area. Figure 4.3.2.2-3 depicts the auditory threshold for seven non-ostariophysine species. The threshold for one of the migratory pelagic species that would be found in the study area, the yellowfin tuna (*Thunnus albacares*) (a non-specialist) is shown to be approximately 120 dB at 50-100 Hz. The figure also portrays the threshold for the codfish *Gadus* to be at about 100 dB. The labrid *Tautoga onitis* (a bony fish with a swimbladder) appears to have the best sensitivity, with a threshold of approximately 75-80 dB in the 50-100 Hz frequency band. The latter two species also do not occur in the study area.

Figure 4.3.2.2-4 depicts the relationship of best hearing frequency vs. threshold for a number of fish species with and without swimbladders. Note that in the 50-100 Hz range for swimbladder fish, the best sensitivity (threshold) is about 80 dB (-20 dB + 100 dB = 80 dB); and for those without a swimbladder (particularly sharks), the threshold moves up to the range of 100-120 dB (via extrapolation). Therefore, measured hearing thresholds in fish span a broad range, from as low as 78 dB in goldfish, to 120 dB or higher in yellowfin tuna. There are, however, very few studies of threshold shifts in fish as a response to low frequency sounds. One such U.S. study involved experiments to ascertain the response of salmonoids to low frequency sound (approximately 200-800 Hz, various source levels below 150 dB) and their ability to hear at these frequencies--tied to the use of low frequency sound to direct winter-run chinook salmon and steelhead away from pumping facilities and agricultural diversions (Estrada, pers. comm., 1995). The results of these tests have not yet been published. Extrapolation from human or marine mammal data (which has served as the basis in previous sections for the generally conservative assumption that a 150 dB level or greater is necessary to produce a temporary threshold shift) may be inappropriate given the morphological differences involved. It is

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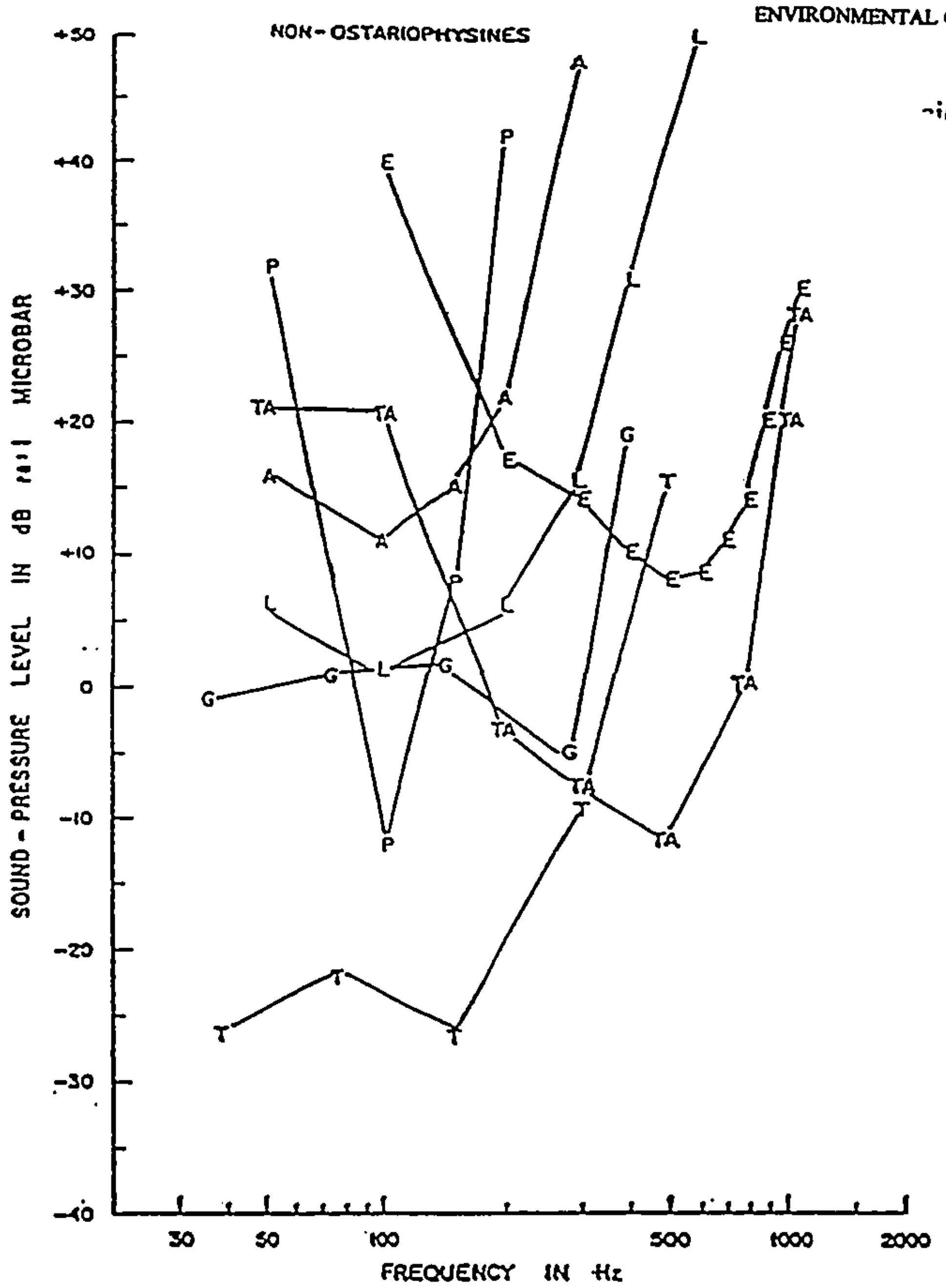
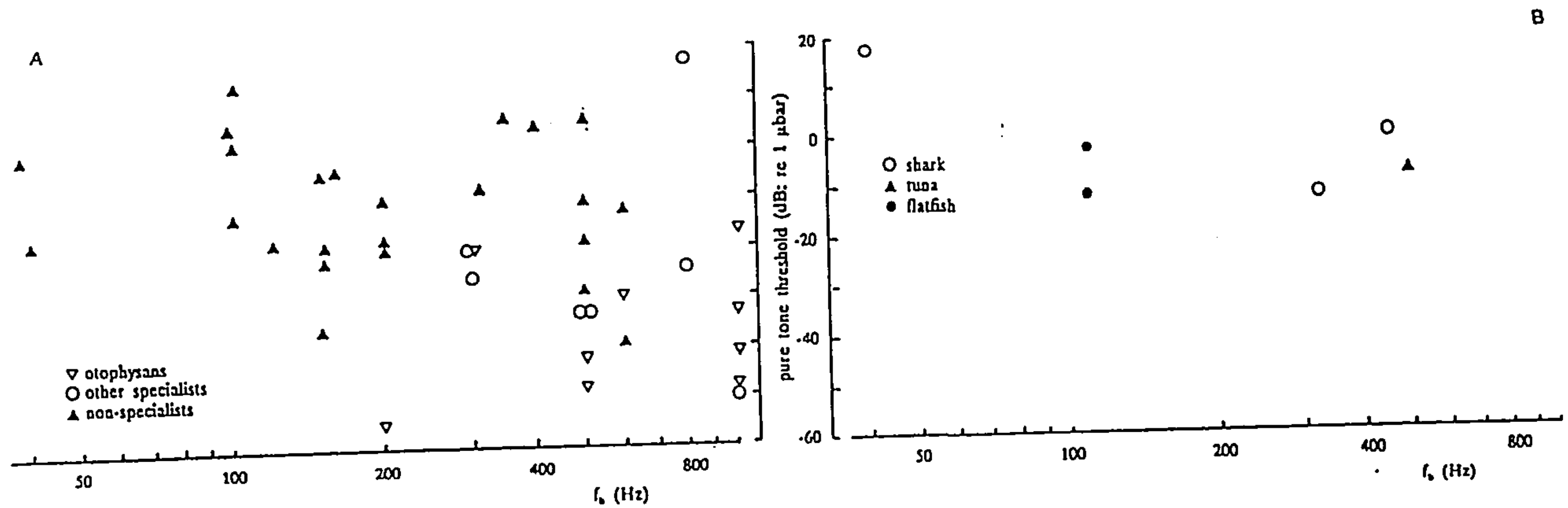


(From Popper and Fay, 1973)

G - *Gadus morhua*, Buerkle; Ta - *Thunnus albacares*, Iversen; E - *Euthynnus affnis*, Iverson; P - *Perca fuviatilis*, Wolff; A - *Acerina cernua*, Wolff; L - *Lucioperca sandra*, Wolff; T - *Tautoga onitis*, Offutt

Note: Add 100 to convert from reference of 1 microbar to 1 microPascal.

Figure 4.3.2.2-3 Auditory thresholds determined for seven non-ostariophysine species



(From Fay (1988a), Abbott (1973) and Jerko et al. (1989). (A) Relation between best frequency and corresponding pressure threshold for swimbladder teleost fish. (B) as A, for six actinopterygian species without swimbladder (3 sharks, 1 tuna, 2 flatfish).
Note: Add 100 to Y-Axis values to convert to dB re 1 microPascal.

Figure 4.3.2.2-4 Relationships between psychophysical pure tone pressure thresholds and best hearing frequency assumed, however, that some threshold shifts in fish could occur as a result of ATOC source transmissions. This is because some fish may reside in the immediate vicinity of the ATOC source, and at least a portion have relatively sensitive hearing.

Fish that hear sound at >1000 Hz usually have a special connection between their swimbladder and inner ear, or a swimbladder that is very close to their inner ear. Hastings (1991) made some general conclusions from evidence based on a thorough literature search that, in the 50-2000 Hz frequency band, received levels at or above 180 dB would be harmful to fish, and received levels below 150 dB should not cause physical harm to fish. For the ATOC project, proportionally few fish are expected to be exposed to levels >150 dB, which would occur within a radius of 178 m from the source proper, encompassing a volume of approximately 0.0118 km^3.

The proposed source site would comprise only a small portion of the range for any fish species. In light of this, plus the low duty cycle and intermittent nature of transmissions, and the uncertainty surrounding the issue of TTS vs. habitat effects in fish, leads to the conclusion that threshold shifts could occur, but their impact on fish populations should be minimal.

> *Mitigation Measure 10-1: The MMRP would monitor fish stock assessments (via Western Pacific Regional Fishery Management Council catch-block landing data; LTPY, CPY, and RAY data from NMFS; and interaction with the Kauai CAG and local fishermen) to attempt evaluation of the potential for increased mortality and predation on fish, in relation to ATOC source sounds.*

The question of possible impact on fish from imposing a resonant frequency on their swimbladders also should be addressed. A few experimental studies of those fish possessing swimbladders (e.g., Sand and Enger, 1973; Popper, 1974) showed that the resonant frequency of the swimbladder is considerably above the frequency of best hearing, and thus probably does not determine the shape of the audiogram. For example, the swimbladder of the codfish, closely examined by Sand and Hawkins (1973), has a natural frequency of pulsation well above the hearing range of the fish (best hearing frequency is approximately 160 Hz), and is almost, but not quite, critically damped. Therefore, it is not expected that resonance plays a significant role in response to low frequency sounds such as the ATOC source.

Sharks are also of interest due to their presumed low frequency sound detection capability. It is apparent that sharks generally do not detect sounds above 1 kHz and that, in most cases, their best sensitivity is to signals below 300 Hz (Popper and Fay, 1977). Sensitivity in lemon and horn sharks is best at about 40 Hz (Nelson, 1967; Kelly and Nelson, 1975). Popper and Fay noted that distinctions between vibration and sound detection are probably not meaningful in a consideration of the shark auditory system.

Figure 4.3.2.2-5 depicts audiograms for three shark species: horn shark (*Heterodontus francisci*), lemon shark (*Negaprion brevirostris*), and bull shark (*Carcharhinus leucas*)(Fay, 1988). Note that the most sensitive hearing for the frequency band 50-100 Hz is attributed to the lemon shark, but its threshold is only about 96-99 dB. The other sharks that have been studied (to the authors' knowledge these three sharks are the only ones for which audiometric data have been obtained) have thresholds 120 dB or higher at frequencies comparable to the ATOC source.

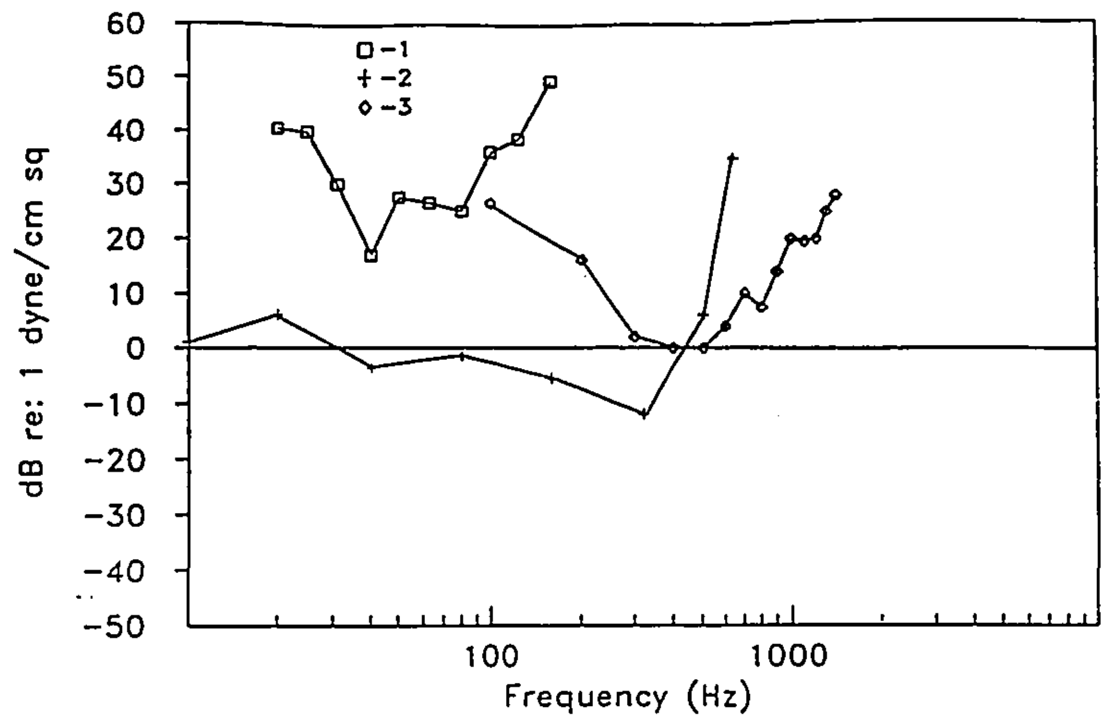
Most fish (including sharks) are not anticipated to be adversely affected by low frequency sounds below 150 dB, and harmful effects are not expected until exposures of 180 dB or greater occur. As with the other species in the project area, exposures to sound levels comparable to those created by the ATOC source already occur due to commercial shipping traffic. As a result, while the potential for impacts to sharks is relatively unknown, it is not anticipated that large numbers of sharks could be adversely affected by the ATOC project; therefore, this impact is assumed possible, but is expected to be less than significant.

Another potential impact from a noisy environment could be effects on fish egg mortality, and fry survival and growth rate (Banner and Hyatt, 1973). These authors noted that under controlled testing conditions, the viability of the eggs of one species of estuarine fish (*Cyprinodon variegatus*) was significantly reduced in aquaria when a low frequency (40-1000 Hz) noise source, at 105-120 dB source level, which was approximately 40-50 dB above ambient noise conditions, was maintained over a number of consecutive days. Further, growth rates of fry in that same species, as well as in another species of estuarine fish (*Fundulus similis*), were significantly less than those noted when noise levels were reduced by about 20 dB during the same time period.

Hastings (1991) postulated a safe zone of 150 dB or lower for fish, which would be at 178 m range from the source, and a potential hazard zone of 180 dB or higher, which is at a distance 8 m or less from the source. This should also apply to fish fry (Hastings pers. comm., 1995). There is no reason to believe that viviparous (internally fertilizing and live-bearing) fishes would be affected by the source transmissions, and the chance of premature release of larvae (already fertilized) occurring as a result of the source transmissions is negligible (Cailliet, pers. comm., 1995). Only a few individual fish would be found in the potential hazard zone, and only a very small number (representing an insignificant proportion of any population of a species) would be found closer to the source than the boundaries of the safe zone, during a transmission (2-8% of the time).

• Potential for behavioral disruption and habituation: For fish species, behavioral disruption refers to cessation of resting, feeding, or social interactions; changes in horizontal and/or vertical movement throughout the water column; and avoidance of the sound field area. Avoidance may mean movement from a site of normal habitation, rapid response swimming toward or away from the sound source, or some combination of these actions. In almost all observations of behavioral disruption, little or no information has been obtained about the duration of the period of altered behavior subsequent to the disturbance (Richardson et al., 1991). Thus, what little information is available almost always pertains to short-term (minutes or, at most, hours) changes in behavior.

Studies have strongly suggested that the noise produced by fishing vessels and their associated gear often results in avoidance by just the animals they wish to harvest (Maniwa, 1971). Continuous underwater construction noise, when within the hearing range, and at



1- *Heterodontus francisci* - horn shark (Kelly and Nelson, 1975)
2- *Negaprion brevirostris* - lemon shark (Banner, 1967)
3- *Carcharhinus leucas* - bull shark (Kritzler and Wood, 1961)

References:
Banner, A. (1967) Evidence of sensitivity to acoustic displacements in the lemon shark *Negaprion brevirostris* (Poey). In P.H. Cahn (ed), Lateral Line Detectors. Indiana University Press: Bloomington, pp. 265-273.
Kelly, J.C., Nelson, D.R. (1975) Hearing thresholds of the horn shark, *Heterodontus francisci*. J. Acoust. Soc. Amer. 58, 905-909.
Kritzler, H., Wood, L. (1961) Provisional audiogram for the shark, *Carcharhinus leucas*. Science 133, 1480-1482.

Figure 4.3.2.2-5 Sound pressure thresholds for 3 shark species reasonably high levels, also can result in fish moving out of the affected regions (e.g., a 500-600 Hz received level of 90 dB at approximately 160 m from the source) (Konagaya, 1980).

The best sensitivity range of the majority of the fish expected in the north Kauai offshore region should be in the 200-800 Hz frequency band. Thus, it is considered unlikely that ATOC sound transmissions would cause any measurable behavioral disruption to the indigenous fish species.

Sharks are difficult to study under laboratory conditions, but (as stated above) several studies have found that they are probably sensitive to both sound pressure, and particle velocity or displacement (similar to goby, perch, ruff, toadfish, tautog, and tuna), and show a similar low sensitivity and narrow bandwidth of frequencies in their hearing range (Banner, 1967; Nelson, 1967; Kelly and Nelson, 1975). As a relative example, Myrberg (1978) reported that a silky shark (*Carcharhinus falciformis*) withdrew from a 300 Hz, 155 dB source level sound at 10 m range. He also noted that a lemon shark (*Negaprion brevirostris*) responded to a 300 Hz sound at 130 dB source level from about 100 m distance. Behavioral evidence indicates that sharks detect underwater sound at low frequencies (<1 kHz), and that certain signals (particularly in the 20-80 Hz range) can attract sharks (Popper, 1977). The effect of pulse intermittency and pulse-rate variability on the attraction of five species of reef sharks to low frequency, pulsed sounds was studied at Eniwetok Atoll, Marshall Islands, during January 1971 (Nelson and Johnson, 1972). The species of shark tested were:

- Gray reef (*Carcharhinidae menisorrah*)
- Blacktip reef (*C. melanopterus*)
- Silvertip (*C. albimarginatus*)
- Lemon (*Hemigaleops fosteri*)
- Reef whitetip (*Triaenodon obesus*)

Three artificial test sounds of identical frequency bandwidth (25-500 Hz) but different pulse characteristics were used, as follows:

- Sound 1: 10 pulses/sec, continuous
- Sound 2: 10 pulses/sec, intermittent
- Sound 3: 15-7.5 decreasing pulses/sec, intermittent

30-sec sequences were repeated ten times to comprise single 5-min playback periods.

A total of 253 sharks were seen during 45 sound playback periods, while 44 sharks were seen during 45 corresponding control periods. Response intensities of attracted individuals, coded in relationship to speed and proximity to the sound speaker, were highest for Sound 3, somewhat less for Sound 2, and least for Sound 1. More importantly, sharks exhibited both intradaily and interdaily habituation to all three sounds during the course of the experiment. Nelson and Johnson (1972) concluded that the attractive value of low frequency, pulsed sounds to sharks clearly is enhanced by intermittent presentation, and that such intermittency contributes more to attractiveness than does pulse-rate variability.

Because sharks are known to be attracted to low frequency signals, they would appear to be one of the best candidates for incurring some level of behavioral disruption due to the ATOC low frequency source transmissions. However, based on the Nelson and Johnson (1972) studies cited above, sharks readily habituated to low frequency, pulsed sounds. Thus, it might be that the attractiveness of the ATOC source emanations would wane over a period of time, given that it would generate more constant transmission characteristics, at duty cycles (transmission periods) of 2%-8%.

Mitigation Measure 11-1: The MMRP would monitor fish stock assessments (via Western Pacific Regional Fishery Management Council catch-block landing data; LTPY, CPY, and RAY data from NMFS; and interaction with the Kauai CAG and local fishermen) to attempt evaluation of the potential for impacts to fish, particularly sharks, in relation to ATOC source sounds.

• Potential for long-term effects: According to Richardson et al. (1991), it is rarely possible to identify the specific cause of any apparent long-term effect (e.g., displacement), and even the occurrence of displacement can be difficult to detect. It is noted, however, that there are a few reports of probable or possible long-term displacements of marine mammals from local areas in which underwater noise was presumably a major factor. Thus, it is possible the same could occur in the case of fish.

If fish do react to noise from human activities by reduced use of certain areas, there is often insufficient reliable and systematic data collected to document the trend. In contrast, it is relatively easy to document cases where fish remain in ensonified areas. Thus, cases of partial, or even complete, abandonment of disturbed areas may, in fact, be more commonplace than expected (Richardson et al., 1991), which could impact the local economy.

Although the potential significance of permanent displacement is difficult to determine, Richardson et al. (1991) speculated that in an area where the density of animals is low, and similar to the densities in many other areas, it is unlikely to be critical either to individuals or to the population. They note, however, that effects of displacement would be more problemmatical in areas consistently used by higher concentrations of animals or areas important to a small but critical component or function of the population (e.g., reproduction).

Animals that appear to tolerate human-made noise are presumed to be less affected by the noise (e.g., through habituation) than are others whose behavior is changed overtly, sometimes with displacement. However, as noted by Richardson et al. (1991), the presence of animals in an ensonified area would not necessarily prove that the population is unaffected by the noise (i.e., the number of animals in the ensonified area may be only a fraction of the numbers that would have been there in the absence of the noise). Also, as noted earlier with regard to marine mammals (Brodie, 1981b), fish, like marine mammals, may remain in an area despite the presence of noise disturbance if there are no alternative areas that meet their requirements.

There is insufficient information to determine whether any adverse long-term impacts to fish could result from ATOC sound transmissions. However, given factors of population density, portions of the range that might be affected, the low duty cycle of the ATOC source, and the deep location of the source, the potential for this impact is presumed low. It should be noted that despite a small potential spatial influence, there could be a temporal influence; i.e., fish exposed at time "t" may not be the same fish exposed at time "t+1." Thus, although the number of fish potentially affected at any one time may be small, over a long period of time, the proportion fish in a population exposed to the sound could be relatively large.

• Potential for masking: The same general principles concerning masking discussed at the beginning of Section 4.3 also apply to fish and sharks. As noted, the maximum radius of influence of noise on a fish is the distance from the sound source at which the noise can barely be detected. This distance is determined by either the hearing sensitivity of the animal, or the background noise level present. To date, there have been only a few studies of auditory masking in fish, and these offer minimal useful data for comparison. Tavolga (1967) was the first to study the effects of noise on pure-tone detection in two non-ostariophysine species. He reported that the masking effect is generally a linear function of masking level, and is independent of frequency. His measurements of tonal thresholds at the edges of a masking band centered at 500 Hz for the blue-striped grunt (*Haemulon sciurus*) elicited tentative suggestions of the existence of critical bands for fish, as in mammals.

Buerkle (1968) addressed directly the question of critical bandwidths in fish, emphasizing five frequency bands within the 20-340 Hz region. It is clear from his data that in fish, as in mammals, masking is most effective in the frequency region of the signal, and that some filtering must be occurring in the fish's auditory system. Chapman and Hawkins (1973) conducted studies on cod, haddock, and pollack in the ocean off the Scottish coast, the results of which showed that masking of hearing thresholds (approximately 78-85 dB in the frequency range 57.5-92.5 Hz) by ambient noise, although negligible in calm sea conditions, invariably occurred at higher sea states. In summary, it appears that masking effects may be even more complex in fish than in terrestrial vertebrates due to the possibility of multiple receptor systems (Popper and Fay, 1973).

Sharks, which rely on highly developed prey detection skills, have exhibited the use of hearing to interpret the sounds of their prey (Banner, 1972; Myrberg et al., 1972; Nelson and Johnson, 1972; Myrberg et al., 1976; Nelson and Johnson, 1976). Such distance-related sensing systems can be affected through masking due to ambient noise levels. Nelson and Johnson (1970) measured the difference in a lemon shark's audio threshold to a 300 Hz, 130 dB source caused by sea state 1 and 2 to be 2 dB, and the difference caused by light vs. heavy vessel traffic (at sea state 1) to be 18 dB. This equated to differences in masking ranges of 45 m for sea states 1 vs. 2, and 110 m for light vs. heavy boat/ship traffic.

Masking effects would be most significant for those species that have critical bandwidths at the same frequencies as the ATOC source, and that do not have other frequency bands of use. This would appear to be the most applicable to sharks. For the three species of shark that audiograms are available (horn, lemon, bull), hearing thresholds at 75 Hz ranged from 99-130 dB, equating to potential masking areas of radius 5 km to approximately 300 km. However, at a 2% duty cycle, it is anticipated that masking would be minor and temporary (98% of the time a shark would be able to perceive prey through low frequency sounds, and effective masking would only occur for environmental sounds shorter than the 20 min ATOC transmission period, that happened to fall within that 20 min window).

• Potential for Indirect Effects: The principal indirect effect on fish and sharks would be any potential impact on the food chain that could ultimately impact fish (as a predator), or other species (in the context that certain fish are their prey) in the vicinity of the study area.

Migratory pelagic fish often feed on smaller fish and zooplankton (e.g., in the deep scattering layer), while sharks usually prey on larger fish, marine mammals, and sea turtles.

One mesopelagic fish species, the lanternfish (Myctophidae), migrates through the water column over a 24-hour cycle, and makes up a significant part of the food chain for many marine animals (particularly baleen whales). While nothing is directly known about the acoustic behavior of myctophids, some of these species may use sound for communication and hear quite well. For example, Marshall (1967) demonstrated that several myctophid species have particular groups of muscles that are likely used for sound production. Popper (1977) published work on the ears of myctophids where, through the use of electron microscopy, it was seen that several species have highly specialized ears, compared to other species, such as tuna, that do not hear well. Based on the study of almost 100 other species, Popper concluded that the ear pattern in myctophids is typical of those species that hear very well.

Thus, any impact of the source on prey populations in the vicinity of the study area could possibly cause indirect effects on fish and marine mammals that rely on that food source. Myctophids make up the bulk of the deepest of three fairly well-defined deep scattering layers, at about 500 m (Castro and Huber, 1992) during the daylight hours. Applying Hastings' (1991) safe received level of ≤150 dB, myctophids would generally have a buffer zone of at least 170 m (500 m depth for the DSL, 670 m depth to the 150 dB sound field). During nighttime periods, the DSL moves toward the surface, expanding the buffer zone to up to 600 m. Therefore, the potential for acute or short-term effects (Table C-1) on myctophids is not anticipated to be significant.

The potential direct, indirect, and cumulative impacts of the proposed project on these prey species are discussed in the following sections of this EIS: invertebrates and plankton, Section 4.3.2.3; odontocetes, Section 4.3.1.2, and sea turtles, Section 4.3.2.1. These sections supplement this discussion of the potential indirect impacts of the proposed project on fish.

4.3.2.2.2 Potential Cumulative Effects on Fish

Activities that could potentially be considered to interact cumulativly to affect fish species off the north coast of Kauai include noise-generating activities: merchant shipping, commercial fishing, and recreational water sports, as well as direct exploitation of fish species by commercial fisheries. The discussions below also account for MMRP-related activities that could potentially cumulate with the source transmissions: 1) aerial visual and acoustic surveys/observations, 2) shipboard visual and acoustic surveys/observations.

Since the level of ambient noise produced by endemic activities cannot be changed, any potential cumulative effects caused by the addition of ATOC sound transmissions are likely to depend, in part, to the degree that fish habituate to repeated noise exposure.

However, noise increases from other potential future sources are speculative; there are no known projects or trends that would have noise impacts cumulating with the ATOC sound transmissions. Any potential for increases of commercial fishing in the area are speculative. As discussed in this EIS, direct impacts to most marine animals are expected to range from minor to negligible. No significant impacts are anticipated when the current project is added to other cumulative changes in the environment.

4.3.2.2.3 Summary and Conclusions Concerning the Potential Effects on Fish

This section summarizes the information presented in the previous sections on potential effects and significance of the ATOC source operations and MMRP on fish.

There is potential for auditory injury for individuals of any species of fish located where received levels are at or above 180 dB (Hastings, 1991), which equates to a radius of about 8 m around the source. However, given the fact that the 5-min ramp-up period may allow sufficient time for fish to depart the area prior to onset of the main transmission, and the small volume involved for the 180-195 dB level, impacts on fish populations should be minimal. The possibility of masking must be stated as uncertain, due to the lack of available data, but is expected to be minimal. In addition, most pelagic species should be far enough away from the proposed source site that they should experience no impacts from the source transmissions. Similarly, those species inhabiting the areas below the depth of the source (i.e., >850 m) should receive less exposure.

Because sharks are known to be attracted to low frequency signals, they would appear to be one of the best candidates for incurring some level of behavioral disruption due to the ATOC low frequency source transmissions. However, based on the Nelson and Johnson (1972) studies cited above, sharks readily habituated to low frequency, pulsed sounds. Thus, it might be that the attractiveness of the ATOC source emanations would wane over a period of time, given that it would generate more constant transmission characteristics, at duty cycles (transmission periods) of 2%-8%. Based on available data, there is the potential for masking low frequency sound used by sharks; although, at a 2% duty cycle, it is anticipated that such masking would be minor and temporary.

It is likely that some fish inhabiting the waters off the north coast of Kauai are able to hear low frequency sounds. They have been observed to move away from fishing boats which generate a high level of low frequency noise, but the effect is short-lived. From the fact that Kauai has a fishing enterprise, harvesting many of the species in the general study area, it could be speculated that these fish probably do not experience any permanent negative impacts due to low frequency sound from fishing boats.

Generally, the impacts are expected to be about the same at each of the alternate project sites, with the exception of the autonomous source. Open ocean species inhabiting the depth of the sound channel would be expected to receive more exposure in the immediate vicinity of an autonomous moored source than they would from any of the alternate sites closer to shore (although the source could possibly be placed in an area devoid of myctophids).

It should be noted that despite the small spatial area of potential influence around the ATOC source, there could be a large temporal component; i.e., fish exposed to the ATOC sounds at time "t" may not be the same fish exposed at time "t+1". Thus, although the number of fish affected at any one time may be small, over a long period of time, the proportion of fish in a population exposed to the source could be relatively large.

Table 4.3.2.2.3-1 summarizes the potential direct and indirect effects, and potential cumulative effects of the alternatives on fish species.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS)	Assumptions: • Sound fields and duty cycle as described for previous species. • Lowest hearing/detection threshold of any indigenous fish species is estimated to be approximately 85 dB for frequencies 57.5-92.5 Hz. • Literature suggests that received levels ≥180 dB harmful to fish, ≤150 dB would cause no physical harm. Volume around source that would encompass received levels ≥150 dB only 0.0118 cu km. • 180 dB sound field volume has radius of only 8 m around source. • For animal in sound field, source may be heard and/ or detected, but maximum duty cycle only 8%, and 5 min ramp-up should allow fish time to swim away, if it is annoyed by sound. • Sharks hear LF sounds but available audiograms indicate best threshold only 96-99 dB in ATOC frequency band. *Uncertain., but presumed Low, provided assumptions are correct.*	Assumptions: • No physical auditory effects. *None*	Assumptions: • Sound fields and duty cycle as described for previous species. • Lowest hearing/detection threshold of any indigenous fish species is estimated to be approximately 85 dB for frequencies 57.5-92.5 Hz. • Literature suggests that received levels ≥180 dB harmful to fish, ≤150 dB would cause no physical harm. Volume around source that would encompass received levels ≥150 dB only 0.0118 cu km. • 180 dB sound field volume has radius of only 8 m around source. • For animal in sound field, source may be heard and/ or detected, but maximum duty cycle only 8%, and 5 min ramp-up should allow fish time to swim away, if it is annoyed by sound. • Sharks hear LF sounds but available audiograms indicate best threshold only 96-99 dB in ATOC frequency band. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • Lowest hearing/detection threshold of any indigenous fish species is estimated to be about 85 dB for frequency band 57.5-92.5 Hz. • Literature suggests that received levels ≥180 dB harmful to fish, ≤150 dB would cause no physical harm.. • Sharks hear LF sounds but available audiograms indicate best threshold only 96-99 dB in ATOC frequency band. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll alternatives because of source parameter differences. • Probably a lower density of fish species could be expected in a selected deep-water site. However, differences in sound fields (compared to Kauai and Johnston Atoll) could offset benefit of fewer fish in the area. *Unknown but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Behavioral disruption and Habituation	Assumptions: • Sound fields (at 100 m depth): - 120 dB 12 km shoreward, 7.5 km seaward from source. - 130 dB 5 km around source. - 140 dB at 288 m depth (562 m range around source). - 150 dB at 672 m depth (178 m range around source. - 195 dB at 850 m depth (1 m range around source). • Duty cycles 2%-8%. • Available data indicate best hearing/detection sensitivity of fish in study area at 200-800 Hz. • Evidence of attraction to LF signals by some shark species. • Max residence time in ensonified area for individual fish/ school unknown, but expected to be <½ day for animals not permanently located within area. • Wide variations in sensitivity to human-made noise between and within species, due to physical and/or biological differences. • Animals would probably tolerate and habituate to noise levels <136 dB at surface, and higher at typical feeding depths, for 2%-8% duty cycles.	Assumptions: • No behavioral disruption or habituation.	Assumptions: • Sound fields and duty cycles comparable to Kauai alternative. • Available data indicate best hearing/detection sensitivity of fish in study area should be in 200-800 Hz frequency range.. • Few fishes in study area spend any measurable time at depths >500 m. • Evidence of attraction to low frequency signals by some shark species. • Maximum residence time within ensonified area is unknown, but expected to be no more than ½ day for those animals not permanently located within the area. • Wide variations in sensitivity to human-made noise between & within species, due to physical and biological differences. • Animals would probably tolerate and habituate to noise levels <135 dB at surface near sound source, and higher at typical feeding depths, for 2%-8% duty cycles.	Assumptions: • Sound fields and duty cycles as described above. • Best hearing/detection sensitivity of fish in study area should be in 200-800 Hz frequency range, as in Kauai alternative. • Evidence of attraction to low frequency signals by some shark species. • Maximum residence time within ensonified area is unknown. • Wide variations in sensitivity to human-made noise between & within species, due to physical and biological differences. • Probably lower density of fish species. However, differences in sound fields could offset the benefit of fewer fish in the area.
	Uncertain, but presumed Low, provided assumptions are correct	*None*	*Uncertain, but presumed Low, provided assumptions are correct*	*Unknown but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate energetic consequences for different fish species or individual fish are unknown; likely to be most critical in areas consistently used by high concentrations of animals or areas important to a small but crucial component or function of the population (e.g., feeding). • Estimated residence time in area as described above. • Potential for stress from sound exposure unknown at 2%-8% duty cycles. • Due to large temporal component, different fish may be exposed to subsequent transmissions, so that although a small number of fish may be affected at any one time, over a long time period, a proportionally large number may be exposed.	Assumptions: • No long-term effects.	Assumptions: • Sound field characteristics and duty cycles comparable to Kauai alternative. • Frequency and duration of disturbance that might initiate energetic consequences for different fish species or individual fish are unknown; likely to be most critical in areas consistently used by high concentrations of animals or areas important to a small but crucial component or function of the population (e.g., feeding). • Estimated residence time in area as described above. • Potential for stress from sound exposure unknown at 2%-8% duty cycles. • Due to large temporal component, different fish may be exposed to subsequent transmissions, so that although a small number of fish may be affected at any one time, over a long time period, a proportionally large number may be exposed.	Assumptions: • Repeated disturbance can result in medium- or long-term displacement of animals. • Frequency and duration of disturbance that might initiate energetic consequences for different fish species or individual fish are unknown; likely to be most critical in areas consistently used by high concentrations of animals or areas important to a small but crucial component or function of the population (e.g., feeding). • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll because source parameters would be different. • Probably a lower density of fish species could be expected in a selected deep-water site. However, differences in sound fields could offset the benefit of potentially fewer fish in the area.
	Uncertain, but presumed Low, provided assumptions are correct.	*None*	*Uncertain, but presumed Low, provided assumptions are correct.*	*Unknown, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Masking	Assumptions: • Sound fields and duty cycles as described above. • Hearing/detection thresholds of some fish species can be masked by vessel noise and high sea states. • Lemon sharks' shift in hearing thresholds (at 300 Hz) due to masking by higher sea states and vessel traffic have been measured to be as much as 18 dB. • For sounds dominated by low frequency components, maximum radius of audibility for fish species may be determined by their hearing capability rather than background noise level. • Masksing effects, if present, would occur only 2-8% of the time, during transmissions. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • No increase in masking. *None*	Assumptions: • Sound field characteristics and duty cycles comparable to Kauai alternative. • Hearing/detection thresholds of some fish species can be masked by vessel noise and high sea states. • Lemon sharks' shift in hearing thresholds (at 300 Hz) due to masking by higher sea states and vessel traffic have been measured to be as much as 18 dB. • For sounds dominated by low frequency components, maximum radius of audibility for fish species may be determined by their hearing capability rather than background noise level. • Masksing effects, if present, would occur only 2-8% of the time, during transmissions. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • Hearing/detection thresholds of some fish species can be masked by vessel noise and high sea states. • Lemon sharks' shift in hearing thresholds (at 300 Hz) due to masking by higher sea states and vessel traffic have been measured to be as much as 18 dB. • For sounds dominated by low frequency components, maximum radius of audibility for fish species may be determined by their hearing capability rather than background noise level. • Cannot assume sound field characteristics comparable to Kauai or Johnston Atoll because of source parameter differences. • Probably a lower density of fish species could be expected in a selected deep-water site. However, differences in sound fields could offset the benefit of potentially fewer fish in the area. *Unknown, but presumed low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on the food chain that could affect fishes (as predator or prey). • Migratory pelagic fishes generally feed on smaller fish and zooplankton; sharks prey on larger fish, marine mammals and sea turtles. • Myctophids make up bulk of deepest deep scattering layer; given that they have hearing capability equatable to other marine animals, received level of 164 dB would be required to cause TTS, which could affect their populations indirectly. • Probably no impact of sound transmissions on fish prey (zooplankton, other fish) or predators of fish (due to change in fish populations), but lack of data makes for uncertainty. *Uncertain, but presumed Low, provided assumptions are correct.*	Assumptions: • No indirect effects. *None*	Assumptions: • Sound field characteristics and duty cycles comparable to Kauai alternative. • Principal indirect effect would be potential impact on the food chain that could affect fishes (as predator or prey). • Migratory pelagic fishes generally feed on smaller fish and zooplankton; sharks prey on larger fish, marine mammals and sea turtles. • Myctophids make up bulk of deepest deep scattering layer; given that they have hearing capability equatable to other marine animals, received level of 164 dB would be required to cause TTS, which could affect their populations indirectly. • Probably no impact of sound transmissions on fish prey (zooplankton, other fish) or predators of fish (due to change in fish populations), but lack of data makes for uncertainty. *Uncertain, but presumed Low, provided assumptions are correct*	Assumptions: • Principal indirect effect would be potential impact on the food chain that could affect fishes (as predator or prey). • Migratory pelagic fishes feed on smaller fish and zooplankton; sharks prey on larger fish, marine mammals and sea turtles. • Myctophids make up bulk of deepest deep scattering layer; given they have hearing capability equatable to other marine animals, received level of 164 dB would be required to cause TTS, which could affect their populations indirectly. • Cannot assume sound field characteristics comparable to Kauai because of different source parameters. • Probably a lower density of fish species could be expected in a deep-water site. However, differences in sound fields could offset the benefit of potentially fewer fish in the area. *Unknown, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. • Recreational water activities.	Assumptions: • Higher proportion of fish populations likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely to occur as number of noise sources increases. • Simultaneous presence of a number of noise sources is expected to increase the potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources is likely to depend, in part, on degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if various noise sources emit similar sounds rather than sounds with varying characteristics. • Limited data on fish species in Hawaiian area shows tolerance to a wide variety of noise-induced human activities.	Assumptions: • No cumulative effects.	Assumptions: • Sound field characteristics and duty cycles comparable to Kauai alternative. • Higher proportion of fish populations likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely as number of sources increases. • Simultaneous presence of a number of noise sources is expected to increase the potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely depends on degree animals habituate to repeated exposures. • Habituation likely to be more rapid and complete if various noise sources emit similar sounds rather than sounds with varying characteristics. • Limited data on fish in Johnston Atoll area shows tolerance to some noise-induced human activities.	Assumptions: • Higher proportion of fish populations likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely as number of sources increases. • Simultaneous presence of a number of noise sources is expected to increase the potential for masking. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources likely depends on degree animals habituate to repeated exposures. • Habituation likely to be more rapid and complete with similar sounds. • Cannot assume sound fields comparable, because source parameters are different. • Probably a lower density of fish species could be expected in a deep-water site. However, differences in sound fields could offset the benefit of potentially fewer fish in the area.
	Uncertain but presumed Low, provided assumptions are correct.	*None*	*Uncertain but presumed Low provided assumptions are correct.*	*Unknown, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.2.3-1. Potential direct and indirect, and cumulative effects on fish.

4.3.2.3 Invertebrates

Hawkins and Myrberg (1983) conclude that some sound-producing invertebrates are capable of communicating with each other; although the significance of such interactions is unclear, and overall little is known about the importance of sound communication in invertebrates. Further, there is minimal experimental evidence of sound reception in invertebrate species. However, some information exists for sound reception in three crustaceans, including the American lobster (*Homarus americanus*), a crayfish (*Cherax destructor*), and brown shrimp (*Crangon crangon*), as discussed below.

Invertebrates are important food sources for many of the other species discussed in this EIS. For example, many invertebrate and fish species forming the deep scattering layer are the prey of sea turtles, other fish, and mysticetes; crustaceans are preyed upon by sperm whales and olive ridley sea turtles; shellfish are eaten by sea otters and loggerhead sea turtles; crabs are the prey of loggerhead sea turtles and various sea lions and seals; squid is an important food source for many odontocetes, as well as sea lions and seals; and octopi are eaten by pygmy sperm whales, dwarf sperm whales and elephant seals. The following sections on invertebrates also constitute a discussion of the potential indirect impacts on these predator species.

4.3.2.3.1 Potential Direct and Indirect Effects on Invertebrates

• Hearing capabilities and sound production of invertebrates: There is experimental confirmation of a sense of hearing in at least one invertebrate, the American lobster, and its audiogram at the ATOC frequency of 75 Hz indicates a hearing threshold value of 120 dB (meaning extremely low sensitivity) (see below). Despite a general lack of experimental evidence for hearing, Pumphrey (1950), Frings and Frings (1964, 1967), Budelmann (1992) and others have suggested that sound reception may be possible among aquatic invertebrates. The suggested acoustic receptors have been many and varied but predominant among them are the following:

- Flow detectors (superficial hydrodynamic receptors)
- Statocysts (internal receptors)
- Chordotonal organs (associated with joints of flexible body appendages)

Flow detectors include sensory cilia, either naked or embedded within a gelatinous cupula projecting into the water, or situated in pits on the body surface, as well as a great variety of other hair-like and fan-like projections from the cuticle, often articulated at the base and connected to the dendrites of sensory cells. Most are considered prime candidates as receivers of water-borne vibration because they are highly sensitive to mechanical deformation, and are in close contact with the surrounding water. The effectiveness of these cutaneous receptors in detecting purely local water movements is evident. Tautz and Sandeman (1980) have stressed that quite short sensory hairs can be effective flow detectors in water. Pumphrey (1950), Harris and van Bergeijk (1962), and Siler (1969) have all stated that low frequency vibrating objects in water show a near-field effect, and although the magnitude of propagated back-and-forth motion is extremely low at a distance, there is a steep increase in amplitude close to the source, which may serve to stimulate an appropriate detector.

Whether these various water-flow receptors are true sound detectors is difficult to answer. Although the organs concerned can detect oscillatory movements, there is still doubt as to whether they are sufficiently sensitive to detect the exceedingly low amplitude water movements found in the far field of the ATOC sound source. Weise (1976), investigating the telson hairs of the crustacean *Procambarus clarkii*, calculated a particle displacement amplitude at a threshold of 0.1 μm (1 μm or micrometer is equivalent to 0.000001 m) at 100 Hz, while Tautz and Sandemen (1980) have directly measured a threshold of 0.6 μm at 100 Hz for the sensory hairs on the chelae of the crayfish *Cherax destructor*. These thresholds would seem to fall far short of the sensitivity necessary in an auditory receptor. To put these figures in perspective, Offutt (1970) claimed a sensitivity threshold of 8.1×10^{-4} μm at 75 Hz for the American lobster. Moreover, fish responding to underwater sounds show calculated displacement amplitudes at the otolith organs of 0.5×10^{-4} μm at 75 Hz for cod (Chapman and Hawkins, 1973), and 3.0×10^{-4} μm at 75 Hz for salmon (Hawkins and Johnstone, 1978). Based on this differential of more than four orders of magnitude, it can be concluded that the water motion detectors of aquatic invertebrates do not approach the sensitivity of fish.

Another type of organ suggested as an auditory receptor is the statocyst, which may be more suitable for the purpose. A statocyst is an organ consisting of a fluid-filled sac which helps indicate position when the animal moves. Unloaded cilia or sensory hairs are almost certainly acoustically transparent, and though they may respond to bulk movements of water that impinge directly on them, sound waves will tend to propagate through them. However, in the statocyst organ, one end of the sensory cilia is often anchored to a mass of sand or calcareous material which has a much higher impedance than the surrounding water. This dense mass tends to remain stationary, while the body tissues move back and forth deforming or shearing the sensory hairs. This form of statocyst reception would pertain mostly to protozoan species (e.g., ciliates and free-swimming tintinnids), and not invertebrates, and probably only peripherally to cephalapods.

It is by no means apparent that the statocyst serves an acoustical function. Any sensory organ loaded with a dense mass will not only respond to sound but will inevitably also suffer deformation under the action of gravity, and linear and angular accelerations. The statocyst likely serves an equilibrium function, and any auditory function may be secondary (Schone, 1971). Although both Pumphrey (1950) and Horridge (1971) suggest that statocysts evolved from stiff cilia which were originally vibration receptors, and that the response to gravity and acceleration is a by-product of an improvement in hearing, there is little experimental support for this view. Some evidence which may indicate an acoustic function is an early paper by Cohen (1955) on the lobster, in which he reported that the statocyst responded to vibrations of the substrate, but the animal exhibited no response to a tuning fork immersed in the water.

Recent literature (Budelmann, 1992) states that statocysts of cephalopods include angular, as well as equilibrium and gravity receptor systems, and because of the latter's gross morphology as linear accelerometers, they should not be categorically excluded as acoustic particle detectors and thus could be involved in underwater hearing as well. However, experiments conducted by M. Clarke (pers. comm., 1993) involving the detonation of dynamite near living captive squid produced no reaction from the squid, suggesting that cephalopods are deaf. There are apparently no other measurements of noise-induced effects on cephalopods. Pertinent data on other invertebrates are addressed below.

A chordotonal organ with two sets of sensory cells has been described in the basal segment of the antennal flagellum of the hermit crab (*Petrochirus*) (Taylor, 1967) and comparable organs exist on the large and small antenna of spiny lobster (*Panulirus marginatus*) (Laverack, 1964; Hartman and Austin, 1972; Rossi-Durand and Vedel, 1982). An extremely sensitive system that is associated with intersegmental joints of the flagellum of the first and second antenna has been described for a crayfish (*Astacus*) (Tautz et al., 1981; Bender et al., 1984). In water, these appendages easily follow an oscillation of the water column surrounding it, whereby they stimulate the chordotonal sensory cells. To date, no experimental measurements have been carried out to quantify the relationship between underwater acoustic pressure and sound threshold levels of chordotonal organs.

Many aquatic invertebrates can generate sound (Hawkins and Myrberg, 1983). Some of these sound producers have been identified, particularly those that contribute substantially to the level of the ambient noise in the ocean. However, little information is available on the importance of sound communication to invertebrate fauna. Most research emphasis has been on the determination of the various sound sources and their sound-producing mechanisms. Among the crustacean sound producers are the barnacles, Balanidae (Busnel and Dziedzic, 1962; Fish, 1964); decapods like the spiny lobsters, Palinuridae (*Palinurus*) (Dijkgraaf, 1955; Moulton, 1957); prawns of the families Palaemonidae and Penaeidae; snapping shrimps of the family Alpheidae (Johnston et al., 1947; Hazlett and Winn, 1962; Fish, 1964); mantis shrimp, *Gonodactylus* (Hazlett and Winn, 1962); and brachyuran and anomuran crabs. Among the molluscs, the common mussel *Mytilus* produces a crackling sound, while squid emit a popping sound (Iversen et al., 1963). Of the echinoderms, some sea urchins produce a "frying" sound (Fish, 1964).

Some of the invertebrate sound producers have no clearly defined vocal organs, and may well be making noise incidentally while performing other natural activities. However, some crustaceans make sounds by mechanisms that have no obvious alternative function. For example, spiny lobsters have a pair of stridulating organs capable of producing a grating or creaking sound, each composed of a series of fine parallel ridges lining a hollow surface on the base of the second antenna. By raising both antennae, the ridges are rubbed along the edge of the rostrum, producing a loud creak (Hawkins and Myrberg, 1983). The provision of this specialized mechanism provides strong evidence that these sounds may serve a communication function (Moulton, 1957).

The sharp, explosive click, or pop, produced by various species of snapping shrimp is generated by a plunger mechanism on the enlarged claw (Johnston et al., 1947). The shrimps' habit of snapping may be associated with defensive and offensive activities, or serve to frighten away predators. However, occasionally snaps are produced spontaneously by undisturbed animals, and are combined with the snapping of other individuals within a large population.

Hawkins and Myrberg (1983) conclude that at least some of the sound-producing invertebrates are capable of communicating with one another, although the significance of their behavior is unclear at this time. Although the sounds generated are impulsive, and therefore contain a wide spread of frequencies, it is likely that only the lowest frequency components are detected by the animals themselves.

• Potential for Physical Auditory or Behavioral Effects:

Experiments with bivalve molluscs, such as clams and mussels, have shown a wide range of cuticular hair organs which are sensitive to oscillatory motion of the water (Laverack, 1962a,b; Tazaki and Obnishi, 1974; Vedel and Clarac, 1976; Weise, 1976; Tautz and Sandeman, 1980). However, researchers still question whether these various water-flow receptors are true sound detectors, and whether they are sensitive enough to detect low amplitude water movements produced by a sound source. Threshold levels seem to fall short of the sensitivity necessary for auditory reception (Hawkins and Myrberg, 1983). Therefore, no physical auditory or behavioral impacts on bivalves would be expected from ATOC source transmissions.

Branscomb and Rittschof (1984) reported that the cyprid larvae of at least one species of barnacle (*Balanus amphitrite*) were inhibited from settling onto structures "protected" by specific low frequency vibrations. Less than 1% of 0-day cyprids settled in the presence of such vibration. Although settlement on the protected surfaces increased with older and apparently less-discriminating larvae, the percentage of metamorphosis was significantly reduced for up to 13 days. Larvae that were prevented from settling merely attached themselves elsewhere. Most interesting were the frequency discriminations noted: 30 Hz signals evoked far superior protection than 15 or 45 Hz. Branscomb and Rittschof believe that such specificity may be due to the adaptive recognition of vibrations produced by natural predators of these larvae.

Offutt (1970) was able to condition the heartbeat of an American lobster to sounds in the frequency range of 10-150 Hz (Figure 4.3.2.3-1 shows the best frequency reception at about 75 Hz, with threshold levels above 120 dB). However, later studies by Hawkins (unpub.) have failed to demonstrate similar abilities in the European lobster.

The only true lobster species in the study area are the Pacific spiny lobster (*Panulirus marginatus*) and the slipper lobster (*Scyllarides squammosus*), which do not inhabit depths below 200 m (the ATOC 120 dB sound field shoreward limitation is approximately the 200 m bottom contour). Thus, these animals should not be subject to sound fields above their hearing threshold and should not be affected by acoustic source transmissions.

Lagardere (1982) reports that several small populations of the brown shrimp (*Crangon crangon*) were reared in sound-proof containers with acoustical noise conditions measured in the 5-1000 Hz band (noise levels of 100 dB on average) similar to those prevailing in their natural environment. Additionally, several similar sized populations were held in non-sound-proofed

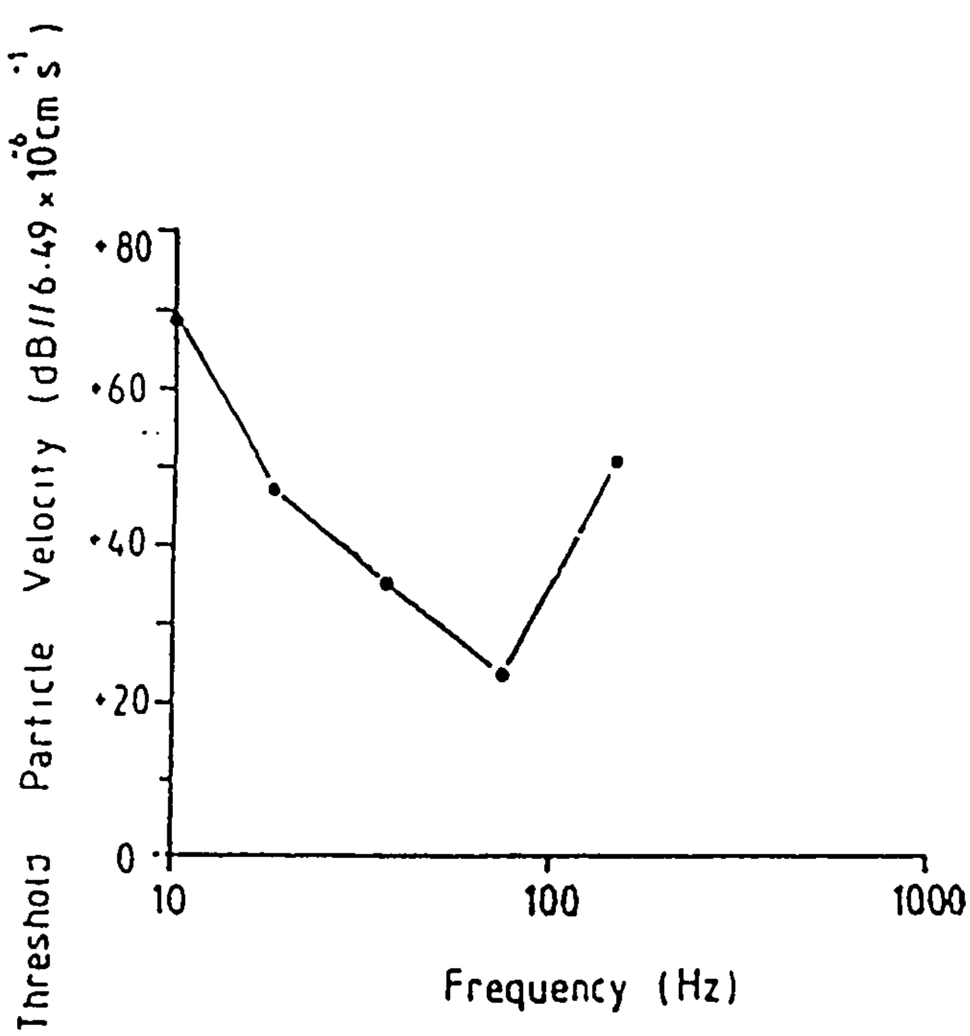


Figure 4.3.2.3-1 Audiogram of the American lobster, Homarus americanus Thresholds are expressed in terms of particle velocity, which corresonds to a sound pressure of 1 microbar in the far field. Add 100 dB to convert to 1 microPascal at 1 m (from Offutt, 1970).

containers that were acoustically louder by about 30 dB in the 25-400 Hz range (i.e., about 130 dB), and about 20 dB louder in the 400-1000 Hz range. After the experimental period of two months, those shrimp reared under the permanently high sound level were shown to have grown significantly less than those held under the quieter conditions, and their reproductive rate was also significantly reduced from that shown by the animals kept under the quieter conditions. To a lesser degree, the higher noise level also appeared to increase aggression and mortality, while decreasing food intake. Previous work on peneid shrimp has shown that when conditions affect both food intake and metabolic rate, as apparently occurred in the case of the shrimp held under the noisy conditions, lipid reserves are reduced (Myrberg, 1990). This leads to polyunsaturated fatty acid deficiency with subsequent slowing of ovarian maturation.

The above-mentioned studies suggest that noise may impact the production levels of certain shrimp species. Figures of sound field estimates in Section 2 illustrate the relatively small area in which ATOC sound transmissions reach the 130 dB level ($\leq$5 km radius). Furthermore, this level would only be attained a maximum of 8% of the time; whereas, Lagardere's study involved continuous sound transmission for two straight months--and the species tested were confined and unable to depart the area of the noise source. On an Leq basis, the 130 dB sound field is a 300 m radius around the source. Given the numerous differences in the conditions of the brown shrimp tests vs. the conditions expected for the ATOC project, the potential for adverse physical or behavioral impact on shrimps from ATOC source transmissions is considered unlikely, although this cannot be definitively stated.

The best evidence for low frequency sound detection in cephalopods is for octopus, cuttlefish, and squid (Karlsen et al., 1989; Packard et al., 1990). Classical conditioning in a standing-wave acoustic tube showed that cephalopods respond to particle motion rather than to the pressure of sound, and that they can be trained to stimuli below 100 Hz, with best results in the range of 1-3 Hz (Budelmann, 1992). *Octopus vulgaris* displays response to particle acceleration on the order of 0.0014 m/sec^2 at 3 Hz, but only 0.16 m/sec^2 at 75 Hz--a decrease in sensitivity of over two orders of magnitude (Packard et al., 1990). A decapod cephalopod (*Sepia officinalis*) exhibits almost the same thresholds to low frequency sounds, except that its best frequency appears to be about 1 Hz (0.00125 m/sec^2), and at 75 Hz it falls off to 0.16 m/sec^2--again, a decrease in sensitivity of over two orders of magnitude (Packard et al., 1990).

In summary, minor decreases in shrimp productivity are possible, but would be expected to affect only a small part of the range of the shrimp (within at most 5 km of the source).

• Potential for long-term effects: Virtually no scientific data appear to exist on the possible long-term effects that low frequency sound transmissions could have on invertebrates. Indeed, very few data are available on the true method of sound reception by individual invertebrate species; limited information is available from such scientific researchers as Sandeman and Okajima, 1973; Tautz and Tautz, 1983; Yoshino et al., 1983; Roye, 1986; and Budelmann, 1992. If invertebrates do react to noise from human activities by reduced use of certain areas, there presently are insufficient reliable and systematic data with which to document any positive or negative trend.

• Potential for indirect effects: Indirect effects include those effects that could potentially be caused by the proposed action and are later in time, or farther removed in distance, but would still be reasonably foreseeable. The principal indirect effect in this case would be any potential impact on the food chain that could ultimately impact invertebrates as predator or prey in the vicinity of the study area.

Potential indirect effects to pelagic and benthic invertebrates could include changes in the distribution and abundance of species that serve as prey for fish and other invertebrates, or that function as predators of invertebrates. Benthic invertebrates, particularly infauna, serve as a primary food source for many species of bottom-dwelling fish and epifaunal invertebrates. Similarly, many pelagic invertebrates, including numerous species that occur in the DSL (such as euphausiid shrimp), are important prey items for pelagic fish, marine mammals, seabirds, sea turtles, and other invertebrates. However, because there are no known benthic or pelagic invertebrates of significant distribution within the potential ATOC sound field, and because of the planned ramp-up period (expected to be beneficial to some, but not all invertebrates [i.e., those that are non-mobile or move very slowly and are located within 8 m of the source]), and limited duty cycle, it is unlikely that there would be impacts on invertebrates (as predators or as prey for other species) from the proposed action.

4.3.2.3.2 Potential Cumulative Effects on Invertebrates

Activities that could potentially be considered to interact in a cumulative sense to affect invertebrate species in the study area off the north Kauai coast include noise-generating activities: merchant shipping, commercial fishing, recreational water sports, marine and nearshore construction, and resort operations. The discussions below also account for MMRP-related activities that could potentially cumulate with the source transmissions: 1) aerial visual surveys/observations, 2) shipboard acoustic surveys/observations.

However, noise increases from other potential future sources are speculative; there are no known projects or trends that would have noise impacts cumulating with the ATOC sound transmissions. As discussed in this EIS, direct impacts to most marine invertebrate species are considered to be unlikely. No major impacts on invertebrate populations are anticipated when the current project is added to other cumulative effects in the environment.

4.3.2.3.3 Summary and Conclusions Concerning the Potential Effects on Invertebrates

This section summarizes the information presented in the previous sections regarding the potential effects of the ATOC source operations and MMRP on invertebrates. Where there is no potential effect or no likely effect even from maximum potential exposures, the project is considered not to have impacts on that species. It should be reemphasized that there is minimal experimental evidence of sound reception in invertebrate species.

No direct auditory injury or deafness are anticipated for any species of invertebrate. There is minimal evidence that marine invertebrates are capable of hearing or intentionally producing sounds; no hearing organs or vocal organs have been identified for most species. One exception is the lobster which research indicates is able to perceive low frequency sound, but only at very high volumes. Since lobsters are not found in water deeper than 200 m, they would not be exposed to sounds loud enough for them to hear.

Research has found that certain shrimp species are less productive when exposed to continuous high sound levels. Shrimp are found both on the seafloor and in the DSL. They provide an important source of food for many larger species of fish and marine mammals. The DSL moves vertically within the ocean, ranging from about 500 m during the day, and migrating to near the surface at night. A small portion of the DSL which happens to be within 350 m of the source during the 2-8% of the time it is transmitting, could be exposed to relatively high sound levels (about 144 dB). However, given the intermittent nature of the transmissions, and the small part of the range of the shrimp exposed, the impacts on shrimp populations are not expected to be significant.

Generally, there is no difference between any of the alternate sites, except the autonomous source, which would be placed in among somewhat different (open ocean rather than shelf and slope) invertebrate communities. Since direct impacts on most invertebrates are considered to be unlikely, the difference in sites is presumed to be inconsequential.

Commercially-taken invertebrates (e.g., squid and octopus) would be monitored, to the extent practicable and feasible, via stock assessments (with fish species; see Section 4.3.2.2.1) to attempt evaluation of the potential for increased predation on invertebrates or changes in their reproductive output.

Table 4.3.2.3.3-1 summarizes the potential direct and indirect effects, and potential cumulative effects of the alternatives on invertebrates.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Physical auditory effects (e.g., TTS) and/or Behavioral disruption and Habituation	Assumptions: • Minimal experimental evidence of sound reception in invertebrates. • Three potential sound receptors: 1) Flow detectors, 2) Statocysts, 3) Chordotonal organs. • Data on cephalopods indicates probable deafness • Limited data on crustaceans (lobster, crayfish, shrimp, barnacles) indicates some capability for sound reception. • American lobster threshold at 75 Hz >120 dB but tropical lobsters inhabit depths <200 m, where sound field is<120 dB. • Controlled shrimp experiment suggests noise >120 dB could possibly affect production rates, but shrimp were subjected to 2 months continuous noise in a closed container; and ATOC 120 dB sound field would be relatively small area.	Assumptions: • No physical auditory effects.	Assumptions: • Assume sound field characteristics and duty cycles would be comparable to proposed action alternative (Kauai). • Assume proposed action alternative assumptions (column 1) are valid for this site.	Assumptions: • Cannot assume sound field characteristics would be comparable to proposed action (Kauai) or Johnston Atoll alternatives because of source parameter differences. • Assume proposed action alternative assumptions (column 1) are valid for this site with the following exceptions: - unknown extent of sound fields could cause impact to shrimps.
	Uncertain, but presumed None, provided assumptions are correct.	*None*	*Uncertain, but presumed None, provided assumptions are correct.*	*Unknown, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.3.3-1. Potential direct and indirect, and cumulative effects on invertebrates.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Long-term effects	Assumptions: • Virtually no scientific data on possible long-term effects of low frequency sound transmissions on invertebrates. • Based on limited available data on possibility of low frequency sound affecting invertebrates in the near-term, it is expected that the potential for long-term effects would be minimal. • If displacement of animals were to occur, analogy with marine mammals suggests density of animals and population functions are determinant factors in assessing potential significance of permanent displacement. *Uncertain, but presumed None, provided assumptions are correct.*	Assumptions: • No long-term effects. *None*	Assumptions: • Assume sound field characteristics and duty cycles would be comparable to proposed action alternative. • Assume proposed action alternative assumptions (column 1) are valid for this site. *Uncertain, but presumed None, provided assumptions are correct.*	Assumptions: • Cannot assume sound field characteristics would be comparable to proposed action or Johnston Atoll alternatives because of source parameter differences. • Assume proposed action alternative assumptions (column 1) are valid for this site with the following exceptions: - unknown extent of sound fields could cause some impact over the long term to some shrimp species. *Unknown, but presumed Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.3.3-1. Potential direct and indirect, and cumulative effects on invertebrates.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
DIRECT and INDIRECT EFFECTS				
Indirect effects	Assumptions: • Principal indirect effect would be potential impact on the food chain that could affect invertebrates (as predator), or other aquatic species that prey upon invertebrates. • Cephalopods feed on deep scattering layer and, in turn, are prey to marine mammals and sea turtles. • Crustaceans feed on other crustacean species and deep scattering layer detritus; they, in turn, become prey for larger marine mammals and sea turtles. • Potential impact of low frequency signals on the food chain relative to invertebrates is uncertain but presumed to be minimal.	Assumptions: • No indirect effects.	Assumptions: • Assume sound field characteristics and duty cycles would be comparable to proposed action alternative. • Assume proposed action alternative assumptions (column 1) are valid for this site.	Assumptions: • Cannot assume sound field characteristics would be comparable to proposed action or Johnston Atoll alternatives because of source parameter differences. • Assume proposed action alternative assumptions (column 1) are valid for this site with the following exceptions: - unknown extent of sound fields.
	Uncertain, but presumed None to Very Low, provided assumptions are correct.	*None*	*Uncertain, but presumed None to Very Low, provided assumptions are correct.*	*Unknown, but presumed Very Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.3.3-1. Potential direct and indirect, and cumulative effects on invertebrates.

POTENTIAL EFFECTS	ALTERNATIVE 1 (Proposed Action)	ALTERNATIVE 2 (No Action)	ALTERNATIVE 3 (Alternate Test Site-Johnston Atoll)	ALTERNATIVE 4 (Moored Autonomous Source)
CUMULATIVE EFFECTS				
• Merchant shipping and other vessel-related activities. • Commercial fishing • Recreational water activities • Marine and nearshore construction and resort operations	Assumptions: • Higher proportion of invertebrate populations likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely to occur as number of noise sources increases. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources is likely to depend on: 1) degree animals might be affected by ATOC signals and 2) degree to which animals habituate to repeated noise exposure. • Habituation likely to be more rapid and complete if various noise sources emit similar sounds rather than sounds with varying characteristics. • Limited data on invertebrates in Hawaiian area shows tolerance to a wide variety of noise-induced human activities. • Limited data shows minimum potential for impact of low frequency sound on invertebrates.	Assumptions: • No cumulative effects.	Assumptions: • Sound field characteristics and duty cycles comparable to Kauai alternative. • Higher proportion of invertebrates likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely to occur as number of noise sources increases. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources is likely to depend on: 1) degree animals might be affected by ATOC signals and 2) degree to which animals habituate to repeated noise exposure. •Habituation likely to be more rapid and complete if various noise sources emit similar sounds. • Limited data on invertebrates in Johnston Atoll area shows tolerance to some noisy activities. • Limited data shows minimum potential for impact of low frequency sound on invertebrates.	Assumptions: • Higher proportion of invertebrates likely to be affected as number of noise sources increase. • Potential for interruption of behavior and possible displacement more likely to occur as number of noise sources increases. • Cumulative increases in impacts speculative due to lack of known future cumulative sources. • Long-term consequences of multiple noise sources is likely to depend on: 1) degree animals might be affected by ATOC signals and 2) degree to which animals habituate to repeated noise exposure. • Cannot assume sound fields comparable, because source parameters are different. • Probably a lower density of lobsters and bivalves/mollusks could be expected in a deep-water site. However, unknown quantities of cephalopods, shrimp, etc., and differences in sound fields could offset this benefit.
	Uncertain, but presumed Very Low, provided assumptions are correct.	*None*	*Uncertain, but presumed Very Low, provided assumptions are correct.*	*Unknown, but presumed Very Low, provided assumptions are correct.*

Note: Relative level of impact/effect: *High, Moderate, Low, None, Uncertain, Unknown.*

Table 4.3.2.3.3-1. Potential direct and indirect, and cumulative effects on invertebrates.

4.3.2.4 Plankton

Zooplankton are addressed primarily because some of their species make up the DSL. As night approaches, these layers rise and become more diffuse, forming again at dawn. In the northern latitudes, where the DSLs are most pronounced, three fairly well-defined layers are often formed. The deepest is at about 500 m, composed mostly of small myctophid fishes (see Section 4.3.2.2 for discussion of potential effects on this fish species); the second at 400-500 m, made up mostly of zooplankton, such as copepods (e.g., *Calanus, Neocalanus, Eucalanus, Acartia*) and krill (e.g., *Thysanopoda, Meganyctiphanes*), and euphausiid shrimps (e.g., *Euphausia pacifica/mutica/recurva*); and an upper stratum, at 300-400 m made up primarily of shrimps (e.g., *Sergestes, Gnathophausia*) (McConnaughey, 1970).

The species discussed below are important food sources for many of the other species discussed in this EIS. For example, many zooplankton species forming the DSL are the prey of sea turtles, fish, and mysticetes. The following sections on the direct, indirect, and cumulative impacts of the proposed action on plankton, therefore, also constitute a discussion of the potential indirect impacts on these predator species.

4.3.2.4.1 Potential Direct and Indirect Effects on Plankton

Copepods comprise the bulk of the zooplankton in the world's oceans. In both numbers of individuals and numbers of species they exceed all the rest of the metazoan plankton combined, and are a key group in the economy of the seas. The free-floating/swimming copepods are usually very small, ranging from 0.2 mm to about 2 cm in length. Copepods of genera *Calanus, Neocalanus, Eucalanus, and Acartia* are widespread in the study area. The greatest swarms of copepods are commonly found in colder waters; however, they do occur in warmer waters, often just as numerous as some of the species characteristic of and limited to warmer regions. No known studies have been completed on the potential impact of low frequency sound transmissions on copepods. Therefore, the reader is referred to the comments made above concerning crustaceans in general.

In summary, no direct short-term impacts to zooplankton are anticipated. Any impact on planktonic abundance in the DSL is likely to be less than comparable effects from indigenous sound sources.

No scientific data are available on the potential for long-term or indirect effects of low frequency sound on zooplankton. However, any change in the status of DSL predators could indirectly affect the planktonic species that make up the DSL. The potential for this occurring is addressed in other sections of this EIS.

4.3.2.4.2 Potential Cumulative Effects on Plankton

Section 4.3.2.3.2, potential cumulative effects on invertebrates, also pertains to zooplankton (particularly copepods). No cumulative impacts are anticipated.

4.3.2.4.3 Summary and Conclusions Concerning the Potential Effects on Plankton

This section summarizes information on the potential effect of the ATOC source operations and MMRP on zooplankton. Where there is no potential effect or no likely effect, even from maximum potential exposures, the project is considered not to have impacts on that species.

No direct auditory injury or deafness are anticipated for any species of zooplankton. There is no direct evidence that zooplankton are actually capable of sound discrimination or intentionally producing sounds; no hearing organs or vocal organs have been identified for those species studied. Therefore, for most species, it appears that no impacts would occur.

Zooplankton are distributed widely throughout the DSL, which provides an important source of food for many larger species of fish and marine mammals. The DSL moves vertically within the ocean, ranging from 400-500 m during the day, and migrating to near the surface at night. Therefore, during the day there is at least a 170 m buffer zone between the zooplankton in the DSL and the 150 dB sound field (500 m depth for the DSL, 670 m to the 150 dB sound field). During nighttime, when the DSL migrates toward the surface, the buffer zone expands to up to 600 m. This, plus the intermittent nature of the transmissions, and the small portion of zooplankton populations exposed (particularly copepods), leads to the conclusion that any impacts are expected to be negligible.

Generally, there is no difference between any of the alternate sites, except the autonomous source, which would be placed in among somewhat different (open ocean rather than shelf and slope) zooplankton communities. Since impacts on most planktonic species are anticipated to be negligible, this difference is presumed to be inconsequential.

4.3.2.5 Seabirds

Section 3 lists the species of seabirds that can be expected to be found off the north Kauai coast. Marine birds are of two types: those that spend most of their time near shore, and those that remain at sea, approaching land only during breeding season. Shore birds and those seabirds that spend most of their time feeding in the coast and nearshore zones, and do not commonly plunge dive, can be considered to be unaffected by any acoustic source transmissions. Those marine birds which remain offshore during most of the year, and do not dive below the surface to forage for food are also unlikely to be affected by either the MMRP activities or acoustic source sound transmissions. The seabirds that would appear to be most susceptible are those species that dive. There are 56 species that may inhabit the Hawaiian Islands, many which dive in search of food, but none that dive deeply (>20 m).

4.3.2.5.1 Potential Direct and Indirect Effects on Seabirds

• Hearing capability of seabirds: Dooling (1978) summarizes psychophysical investigations of hearing in a number of avian species during the 1968-1978 timeframe. He 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. On the basis of this general measure, birds fall between two other major vertebrate groups: reptiles and mammals, but avian hearing performance is clearly inferior to that for mammals above and below the 1-5 kHz range of frequencies. Possible exceptions to this general picture include the oilbird (*Steatornis caripensis*) and growing evidence that some pigeon species (*Columba spp.*) are sensitive to infrasound at moderate intensity levels. Neither of these avian species inhabit the north Kauai offshore area.

Fay (1988) states that the outer ear of birds includes a feather-covered external canal, with no pinna, as it is usually conceived. The feathers covering the external canal seem to be specially adapted for minimizing air turbulence (and thus noise) during flight. Fay goes on to discuss the bird middle ear, which is similar to those of amphibians and reptiles, in that it has a single major ossicle, the columella or stapes. The efficiency and frequency response of bird ears is not unlike that of mammals below about 2 kHz. Fay notes that the inner ear of birds includes a cochlea, in addition to an associated lagena, and the vestibular saccule, utricle, and semi-circular canal cristae. The function of the lagena is not known, but may serve as a very low frequency sound detector. The cochlea is elongated and slightly "bent," similar to the auditory papillae of some reptiles. A cross-section of the bird basilar membrane and papilla shows many rows of hair cells which vary in height across the membrane. Fay says that there is, as yet, no clear evidence for a classification of inner and outer hair cells as there is among mammals.

Audiograms in air for about 22 different bird species show their best sensitivity to be in the frequency range of 1-3 kHz as shown in figure 4.3.2.5.1-1. Among the 22 audiograms available, the species that would be most closely related to seabirds is a mallard duck, which had a hearing threshold in air of about 70 db re 20 μPa at 75 Hz (extrapolated) (Trainer, 1946). Applying the formula for conversion of sound pressure level from air to water, albeit a speculative technique in this case, the duck's threshold would be 131.7 dB re 1 μPa.

• Potential for physical auditory effects: Seabirds that forage for food at sea by plunging or diving beneath the surface would be more likely impacted than surface feeders. Seabirds that perch or hover at the surface but do not plunge dive are obviously less at risk, and the potential for any significant number of these animals to be on the water's surface within the 130 dB sound field (see Section 2) during acoustic transmission is low. Any seabirds in the area would be expected to fly away if they detected and were annoyed by the 5 min ramp-up sound prior to the main signal transmission.

Using the mallard duck's audiogram measurements as a rough order-of-magnitude example, its hearing threshold equates to a sound field of only 0.00073 km^2 area around the source site within which the seabird would have to be located to hear the signal during source transmission. Therefore, no impacts are anticipated. If a seabird's threshold is lower than the example given, the sound field area would expand proportionally.

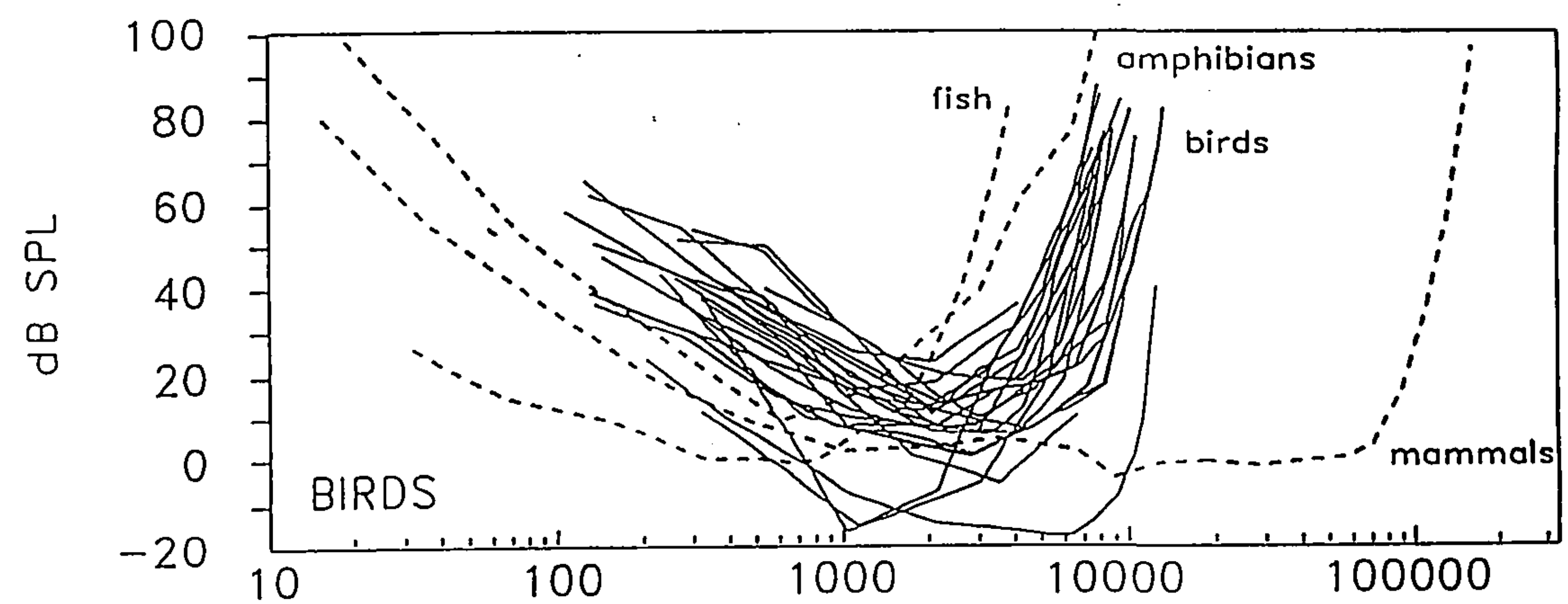


Figure 4.3.2.5.1-1 Available valid bird audiograms
Heavy line encloses threshold points, excluding about 10% of the lowest thresholds, providing a reasonable envelope for the hearing range of birds. (From Fay, 1988)

Because of the lack of audiometric data that is directly relatable to seabirds, another way to attempt to ascertain the potential impact of the acoustic source transmissions on deep-diving seabirds is the conversion of known safe underwater explosion thresholds to sound pressure levels that can be related to the proposed source sound field parameters, although it should be emphasized that the criteria of Yelverton et al. (1973) apply to sharp shock-wave pulses. Yelverton calculated the safe underwater explosion thresholds for seabirds to be the following:

- Seabirds on the surface: 30 psi-msec
- Seabirds diving below the surface: 20 psi-msec

In converting to decibels, numerical calculations yield the relationship [1 psi-msec = 6.895 Pa-sec], given the assumption that explosive source level units are Pa-sec, and spherical spreading is used for transmission loss. It can be derived from these values that an acoustic transmission of 195 dB source level attenuates to below 15 psi-msec within 100 m range from the source. Therefore, with the proposed source at approximately 850 m depth, no seabirds, either on the surface or during a dive, would be subjected to received levels near 20 psi-msec.

Based on the above information, it is anticipated that any effects on seabirds, either directly or indirectly, as a result of MMRP activities or acoustic transmissions, would be negligible.

4.3.2.5.2 Potential Cumulative Effects on Seabirds

Activities that could potentially be considered to interact in a cumulative sense to affect seabird species in the region off the north Kauai coast include noise-generating activities: e.g., merchant shipping, commercial fishing, recreational water sports, marine and nearshore construction and resort operations.

Noise increases from other potential future sources are speculative; there are no known projects or trends that would have noise impacts cumulating with the proposed sound transmissions. As discussed in this EIS, the potential for direct impacts on most marine animals are expected to range from uncertain to negligible. No significant impacts are anticipated when the current project is added to other cumulative changes in the environment.

Since the potential for direct impacts on seabirds is anticipated to be negligible, and given the speculative nature of any increase in other noise sources, any cumulative impact on seabirds is anticipated to be negligible.

4.3.2.5.3 Summary and Conclusions Concerning the Potential Effects on Seabirds

This section summarizes the information regarding potential effects of the ATOC source operations and MMRP activities on seabirds. Where there is no potential effect or no likely effect even from maximum exposures, the project is considered not to have significant impacts on that species.

No adverse effects are anticipated for any species of seabird. Research data on a mallard duck suggest that [seabirds] do not hear low frequency sounds well, which supports the premise that the source transmissions should produce negligible impacts on seabirds.

Because the relevant factors are similar at each of the alternate sites, the potential for impacts would be expected to be negligible at all of them.

4.3.2.6 Threatened, Endangered and Special Status Species

Table 3.3.7-1 lists all 15 of the threatened, endangered, or special status marine species that could occur offshore Kauai or Johnston Atoll. All four mysticetes (blue, fin, humpback and right whales) are addressed in Section 4.3.1.1. The one odontocete (sperm whale is addressed in Section 4.3.1.2. The one *pinniped (Hawaiian monk seal)* is addressed in Section 4.3.1.3. The four sea turtles (leatherback, green, olive ridley, and hawksbill) are addressed in Section 4.3.2.1. The potential for any impact on the four seabirds (Newell's shearwater, black-footed albatross, Laysan albatross, short-tailed albatross, and the Hawaiian dark-rumped petrel) is addressed in Section 4.3.2.5. As concluded in those sections, potential impacts on these species ranges from uncertain to low/moderate.

4.3.2.7 Marine Sanctuaries and Special Biological Resource Areas

There are two categories of marine sanctuaries and special biological resource areas: 1) offshore areas, and 2) nearshore areas. The former includes the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS).

As discussed in Section 5, the proposed project is consistent with the management plan for the HIHWNMS.

Nearshore areas include the Kilauea Point National Wildlife Refuge on the north coast of Kauai, and the Johnston Atoll Federal Bird Refuge.

These areas are so close to the shoreline (where project source sound fields would be highly attenuated) that no impacts are anticipated on any species found therein due to proposed action or MMRP activities.

Therefore, it is expected that the potential for direct, indirect, or cumulative effects on offshore marine sanctuary resources is minimal, and for nearshore special biological resource area resources no impacts are expected.

4.3.2.8 Cable Route Biota

Section 3.3.9 lists the species that could be expected to inhabit the region along the cable route in the shallow subtidal zone (area between the low tide level and 24 m depth), the shallow nearshore zone (24-50 m depth), the coral reef (45-67 m), and the deeper shelf and slope zones. The potential effects of low frequency sound on marine mammals, sea turtles, fish, invertebrates, plankton, and seabirds have been addressed in previous sections. Given the lack of benthic biota at depths >24 m that could potentially be affected due to cable and source installation, this subsection focuses on the subtidal and nearshore zones. Since proposed source transmissions should have no effect on marine plant or animal life in nearshore water depths <24 m, attention can be directed toward any possible impact the cable itself could have on biota along its route.

4.3.2.8.1 Potential Direct and Indirect Effects on Cable Route Biota

In the shallow subtidal zone, benthic biota would only be affected if the cable happened to be laid across one or more of the plants/animals themselves. Even if this were to occur, it would not likely have any permanent or long-range effects on this resource. Mobile animal species in the shallow nearshore region include fish (wrasses, goatfish, damselfish, etc.), and invertebrates, such as lobster, crab, sea stars, sea urchins, that should not be affected by the cable, either during or after its installation. Most of these species would merely move away during installation and return thereafter. Reef-building corals and other sessile invertebrates would be avoided during facility installations. Once the cable is in place, the status of the benthic and intertidal biota would be expected to rapidly return to an environmental steady-state condition.

4.3.2.8.2 Potential Cumulative Effects on Cable Route Biota

It is expected that any potential cumulative impacts on subtidal or nearshore biota due to the installation of the cable and its subsequent use would be unlikely, given the lack of any anticipated projects that would have impacts that could cumulate with this project, and the lack of impacts from the proposed project itself.

4.3.2.8.3 Summary and Conclusions Concerning the Potential Effects on Cable Route Biota

Minimal effects are anticipated on any plant or animal species expected in the shallow subtidal or nearshore zone. Therefore, cable installation and subsequent operation should produce negligible impacts on the biota along the cable route. There is minimal difference between the two alternate sites proposed, because neither of them should produce any more than negligible impacts on the nearshore or subtidal biota that may be found along the cable routes.

4.4 POTENTIAL EFFECTS ON THE ECONOMIC ENVIRONMENT

This section addresses the potential effects of the proposed action on Kauai's economic environment. Direct effects evaluated in this section are the potential for increased economic activity due to the project. Indirect effects refer to the potential effects on Kauai's economy should any adverse impacts on marine mammals or other species discussed above occur.

Generally speaking, economic effects of a project are outside the scope of NEPA and HEPA. However, economic effects can result in environmental impacts where, for example, economic development induced by a project could result in population growth. Economic effects can also answer the question of whether an environmental effect is important. Under HEPA, beneficial economic effects can also support a statement of overriding considerations that allow project approval despite one or more potential impacts. Economic effects generally are not considered important unless they would result in substantial public service and infrastructure costs that would not be offset by project revenues, or where the project would otherwise impose substantial costs on non-participants.

4.4.1 POTENTIAL DIRECT AND INDIRECT EFFECTS ON THE ECONOMIC ENVIRONMENT

The Hawaiian Archipelago shelf and slope off north Kauai support an economically valuable range of commercial fisheries utilizing a variety of retrieval methods. In 1990, a combined total of approximately 10 million kg of fish, with an ex-vessel value exceeding $50 million was landed at the ports of Hawaii. Given the depth of the sound source, the minor extent of the sound fields, the low duty cycle (most of the time only 2%), the five-minute ramp-up period that would give all mobile marine animals the opportunity to depart the immediate area of the source if the sound was annoying, and the habitat range of the major commercial, recreational, and subsistence fish species, any potential effect on the economic environment is expected to be negligible. See Sections 3.3.3 and 4.3.2.2.

Direct effects of the proposed project would be limited to the beneficial impact of program expenditures on the Kauai economy. These include payrolls for labor incurred, expenditures for supplies and equipment, and other monies spent.

Marine mammals are no longer a direct economic resource for Hawaii, and they are almost all protected from exploitation. Commercial fishing is an important economic activity, but it is not anticipated that the MMRP or sound transmissions would have a material adverse impact on fish or invertebrates, as discussed above. Direct effects on the economy through reduction of tourism could occur if changes in marine mammal abundance or behavior would occur. Reduction in tourism, for example, could result from impairment of such tourist-related activities as whale/dolphin/sea turtle watching and sport fishing. As discussed above, potential impacts on certain species of whales (i.e., sperm and beaked) and leatherback sea turtles are uncertain; however, for most other species, including sport fishes, less than significant impacts would be expected. The possibility that whales would alter their courses slightly to avoid the 130 dB (or 120 dB) sound field could have an effect on area whale-watching enterprises. Such a dramatic change in behavior is uncertain.

Because of the absence of tourism at the Johnston Atoll alternate site and any selected remote autonomous source locations, no direct or indirect economic impacts would be anticipated from those alternatives.

Generally, the direct economic effect of the project would be minor, but beneficial, resulting from increased economic activity due to payrolls and support expenditures.

4.4.2 POTENTIAL CUMULATIVE EFFECTS ON THE ECONOMIC ENVIRONMENT

• Merchant shipping and other vessel-related activities: If the abundance of whales, odontocetes, sea turtles, the one species of pinniped, or fish were to be appreciably decreased, it could be surmised that a proportional decrease in tourist activity could occur. This could be related directly to the level of merchant shipping (fish catch transfers, and long-range transport out of Hawaii). Other vessels would include such commercial activities as whale-watching tours, which would obviously be impacted if there were fewer whales in the area. Previously presented data and information have quantified the potential for acoustic source transmissions adding to any cumulative effect. There should be no impact on any tourist industry economic base related to merchant shipping or other vessel-related activities.

• Recreational water activities: The same conclusions apply to the potential for acoustic sound transmissions changing the cumulative effect of this activity. There should be no impact on the economy of tourism (from recreational water activities) due to the adoption of any of the alternatives.

• Aircraft operations: The addition of acoustic sound transmissions into the environment would cause no potential change in the cumulative effect of aircraft noise in the area. Further, there would be no expected change in any cumulative effect due to the addition of MMRP aerial surveys and observations. Therefore, there should be no impact on any economic base related to aircraft operations.

• Scientific research activities: No potential change in the cumulative effect of ongoing and planned scientific research being conducted on mysticetes, odontocetes, sea turtles, the one pinniped species, or fish would be expected by the addition of MMRP activities related to acoustic sound transmissions and associated aerial and vessel activities. MMRP research has been designated as *bona fide* and non-duplicative in nature, and would be coordinated and integrated with all associated marine animal research to ensure maximum cost-leveraging and scientific synergism. Thus, the potential for any impact on the economic environment due to any of the alternatives would be expected to be positive.

In summary, the potential impacts on the economic environment from the proposed action would not be expected to contribute to cumulative adverse impacts.

4.5 POTENTIAL EFFECTS ON THE SOCIAL ENVIRONMENT

Any potential effect on the social environment would be related to the human environment, as discussed below.

4.5.1 HUMAN ENVIRONMENT

4.5.1.1 Potential Direct and Indirect Effects on the Human Environment

The following discussion addresses potential impacts to the human environment in the following areas:

• Population dynamics: No potential direct or indirect effect on population dynamics would be expected due to any of the alternatives being implemented.

• Educational institutions: As previously stated, opportunities for direct interaction and hands-on marine animal data display and analysis would be offered to Hawaii educational and environmental institutions. The MMRP marine mammal biologists and research scientists could provide access to their data for students to explore and manipulate and learn about the process of marine science. By making such information available to the local teachers, students and interested community members through education efforts, the positive impact of the ATOC/MMRP project is increased greatly. Thus, the potential for any direct or indirect effects on local educational establishments would be expected to be only positive in nature. No such interaction would be readily available at Johnston Atoll or a deep-water site.

• Recreational and leisure activities: Whale, dolphin, monk seal, and sea turtle-watching, and sport fishing have already been covered previously. The only other human activity that could potentially be impacted by the proposed acoustic source sound transmissions would be recreational diving. The potential for impacts is expected to be minimal since most recreational diving occurs in the nearshore region. The following discussion is provided:

Low frequency sound transmitted in the vicinity of humans underwater could potentially produce one or more of the following effects, all of which will be addressed in the following paragraphs:

1) Potential impact on hearing sensitivity; e.g., temporary threshold shift (TTS)
2) Potential resonance of air-containing cavities; e.g., intrathoracic (thoracic pertains to the chest cavity, encompassing the heart, lungs, some of the respiratory passages, and the esophagus)
3) Potential impact on mechanoreceptor cell function (e.g., Pacinian corpuscles)
4) Potential human acoustic annoyance

Potential Impact on Hearing Sensitivity

Loud underwater noise could potentially impact a diver's hearing depending, of course, on the noise's frequency, source level, pulse characteristics and length, and the range of the diver from the source itself. Some experiments dealing with underwater thresholds of audibility have been conducted, beginning with Sivian's work in 1943, continuing up to today. The results of these experiments are so disparate that it is very difficult to establish a direct relationship between underwater and in-air hearing for humans with a great deal of confidence. If a realistic transformation between water and air could be determined, then in-air noise exposure limits could easily be applied to the underwater environment. Kirkland and Pence (1989) evaluated all known experiments as to potential weaknesses or areas of uncertainty in an effort to establish their validity and better define the air vs. water hearing relationship in the case of humans. Some of the key deficiencies noted have included high or unknown ambient noise levels, a lack of monitoring of the actual in-water sound field at the diver's position, and a lack of objective information on the quality of each subject's hearing (i.e., no in-air hearing sensitivity data). On the basis of these key deficiencies, the results of a number of the experiments in question, Kirkland and Pence concluded, can be set aside as being relatively unreliable, and the remaining better experiments can be further evaluated as a group, namely the seven following reports:

- Hamilton (1957): "Underwater Hearing Thresholds"
- Smith, P. (1965): "Bone Conduction, Air Conduction, and Underwater Hearing"
- Hollien et al. (1967): "Underwater Hearing Thresholds in Man"
- Hollien et al. (1969): "Effect of Air Bubbles in the External Auditory Meatus on Underwater Hearing Thresholds"
- Hollien et al. (1969): "Underwater Hearing Thresholds in Man as a Function of Water Depth"
- Smith, P. (1969): "Underwater Hearing in Man: I. Sensitivity"
- Hollien and Feinstein (1975): "Contribution of the External Auditory Meatus to Auditory Sensitivity Underwater"

The agreement among the results obtained by these three investigators, although not perfect, was generally good. Using their data, an average corrected underwater human hearing threshold of audibility (for young listeners with normal hearing) as a function of frequency can be derived (Figure 4.5.1.1-1). Adjustments were made to the original data to account for the different hearing sensitivities of the subjects and, where appropriate, for the change in audiometric standards that occurred during the 1964-1970 timeframe (ASA Z24.5-1951, changing to ISO 389-1964 or ANSI S3.6-1969). Underwater thresholds represented by this average curve are generally lower than those presented by most of the other investigators, lending a measure of conservatism to the results. Given that these are the best data available, because the low end of the frequency spectrum portrayed is just above 100 Hz, the average curve must be extrapolated down to 75 Hz. Audiograms of other mammals (monkey, rat, cow, elephant, dog, oppossum, bat), some birds (canary, barn owl) and a reptile (turtle) all display linear progression (upwards) below 100 Hz, indicating direct extrapolation of the humans' audiogram beyond 100 Hz to 75 Hz is justifiable. This technique yields a minimum audibility level of 82 dB re 20 μPa which, in turn, must be converted to the standard of 1 μPa by adding 26

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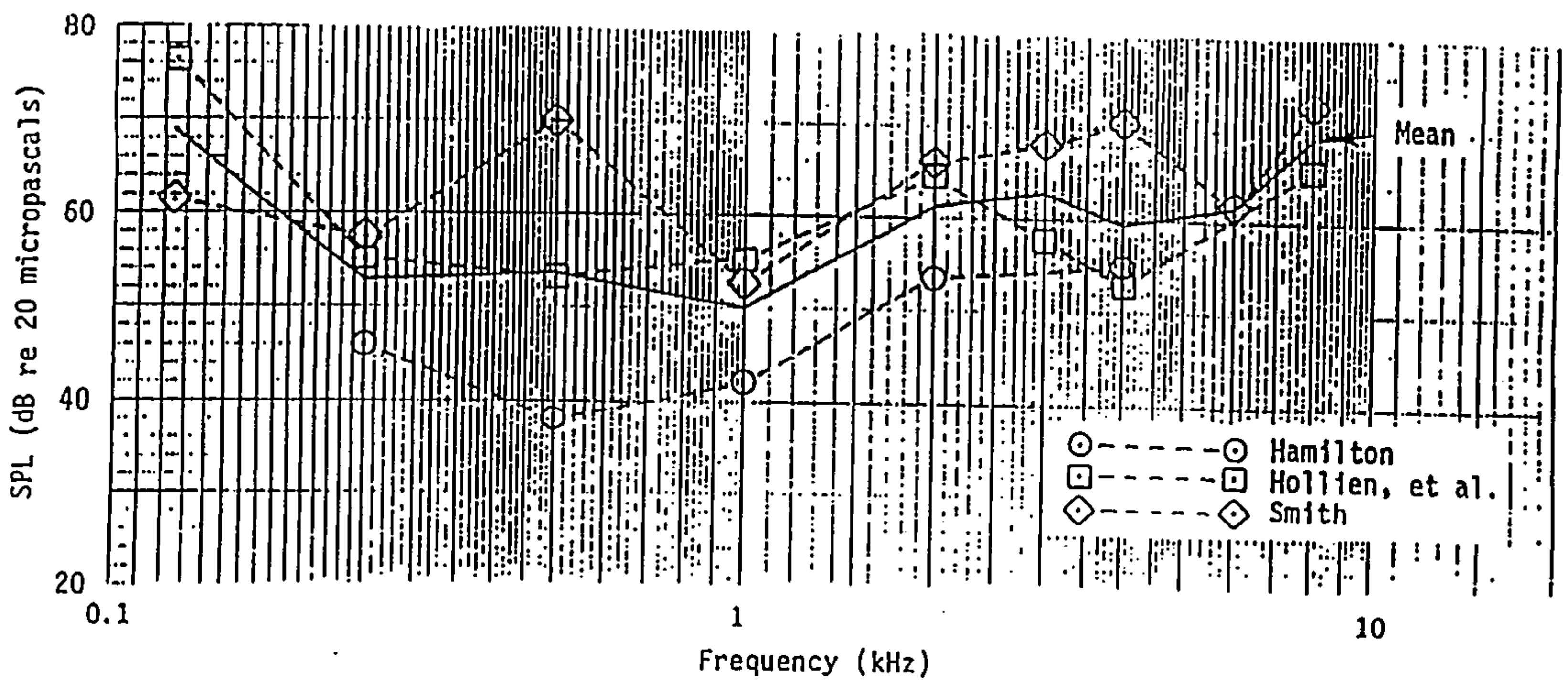


Figure 4.5.1.1-1 Average corrected underwater thresholds of audibility over all experiments conducted by each of three investigators. The overall mean is based upon treating each experimental group as an independent data point (Hamilton-one experiment, Hollien-three experiments, Smith-two experiments)

Note that the single data point at six kHz is from only a single experiment by one investigator and, therefore, does not represent a realistic average. (from Kirkland and Pence, 1989) dB (Table 4.5.1.1-1) to attain the required value of 108 dB re 1 μPa for minimum human audible threshold in water for a frequency of 75 Hz.

Temporary threshold shifts have been produced in humans for frequencies between 700-5600 Hz (human's most sensitive hearing range) with underwater sound sources at 150-180 dB re 1 μPa (Montague and Strickland, 1961). As previously discussed, the value of 80 dB should be added to 108 dB to arrive at 188 dB for the level at which TTS could possible occur in humans at 75 Hz. Thus, for this to occur, the diver would have to virtually be touching the acoustic source during the short transmission period, which is literally an impossibility because of the 850 m source depth. Therefore, it is safe to predict that the proposed acoustic source transmissions should have no direct or indirect environmental effects on human hearing capability.

Potential Resonance of Air-Containing Cavities

High levels of underwater narrowband noise have been found to cause non-auditory effects. Montague and Strickland (1961), Molvaer (1981) and Smith (1985) have reported temporary threshold shifts, nausea or vertigo resulting from close (near-field) exposure to underwater tools and tones in the range of source levels 156-216 dB re 1 μPa. In tests ensonifying divers with a sweep oscillator producing acoustic energy in the frequency band of 10-32 Hz, Nishi (1972) reports "little discomfort at ranges greater than 4.6 m for all frequencies in the band (180 dB re 1 μPa). The discomfort which was experienced seemed to be greater when the frequency of the sound emitted was at the upper end of the band."

While many authors discuss the importance of air-containing structures within the human body relative to sound-induced motion underwater, the importance of hyperbaric effects have not been generally noted. In order to derive some initial information, reinterpretation of Young et al.'s (1985) experimental results can be carried out. Young made measurements of intrathoracic (internal lung) pressure on ten healthy young male subjects exposed to an airblast. While such data are typically interpreted relative to time, it is valuable to reinterpret this information for the "at surface" condition (Figure 4.5.1.1-2). Note that the model indicates a peak response to incident sound at just over 100 Hz, which is in agreement with other published results. This intrathoracic pressure is about twice that of the external incident pressure at the resonant frequency, indicating a degree of enhancement of the pressure by resonance.

The increase in resonant frequency of air-containing structures with depth has been understood for a considerable time, probably commencing with Minnaert's (1933) study of bubble noise. Therefore, the resonant frequency of an air-containing space of a diver is expected to increase with depth as the square root of the absolute pressure; thus, if the thorax resonates at 100 Hz at the surface, it may be expected to resonate at 200 Hz at 30 m depth, and 250 Hz at 50 m depth. Recent experimental results, for approximately 1.5 m distance from the diver (unpub., 1993; restricted access due to military security classification), indicated that there are two ranges of frequency at which divers experience effects of low frequency noise. The most significant was at a frequency of about 100 Hz at source levels of about 160 dB re 1 μPa-m: resonance of the diver's face mask and possibly sinuses. The next most significant was at a frequency of

To Convert		Add or subtract according to sign
From	To	
SPL re 1 $dyne/cm^2$	SPL re 20 micropascals	+73.98 dB
SPL re 1 microbar (μb)	"	+73.98
SPL re 1 micropascal (μPa)	"	-26.02
SPL re 0.0002 $dyne/cm^2$	"	0
SPL re 2 x 10^{-5} $newton/m^2$	"	0
		air / sea water
IL re 10^{-16} $watt/cm^2$	"	0[a] / +35.83[b]
IL re 10^{-12} $watt/m^2$	"	0[a] / +35.83[b]

[a]The conversion value of 0 dB is only valid when the characteristic impedance of the medium (ρ_0c) is equal to 400 newton-sec/m^3 (or 40 dyne-sec/cm^3). The impedance ρ_0c for air will depend upon temperature and pressure. For example, at 22°C and 0.751 m Hg ρ_0c = 407 newton-sec/m^3. For these conditions, the intensity level would be 0.1 dB smaller than the sound pressure level. The exact relationship between intensity level and SPL is $IL = SPL + 10 \log_{10} 400/\rho_0c$ dB, where ρ_0c has the units newton-sec/m^3. (Example and equation from Beranek, 1986, pg. 14.)

[b]The conversion value of +35.83 dB is based upon a sea water density (ρ_0) of 1.026 gm/cm^3 and a nominal sound speed (c) of 4900 ft/sec (1493.5 m/sec). The sound speed in water depends upon temperature, salinity, and pressure.

Some symbols and units:

- watt: unit of electrical power, 1 watt = 1 joule/sec = 10^7 erg/sec = 10^7 dyne-cm/sec = 1 N-m/sec.
- SPL: sound pressure level.
- IL: intensity level.
- dyne: unit of force, 1 dyne = 1 gm-cm/sec^2.
- pascal: unit of pressure, 1 Pa = 1 N/m^2 = 10 dyne/cm^2.
- newton: unit of force, 1 N = 1 kg-m/sec^2.
- microbar: unit of pressure, 1 microbar = 1 dyne/cm^2.
- rayl: unit of impedance, 1 rayl = 1 dyne-sec/cm^3, 1 mks rayl = 1 newton-sec/m^3.

Table 4.5.1.1-1 Conversion of sound levels using various references to sound levels re 20 micropascals

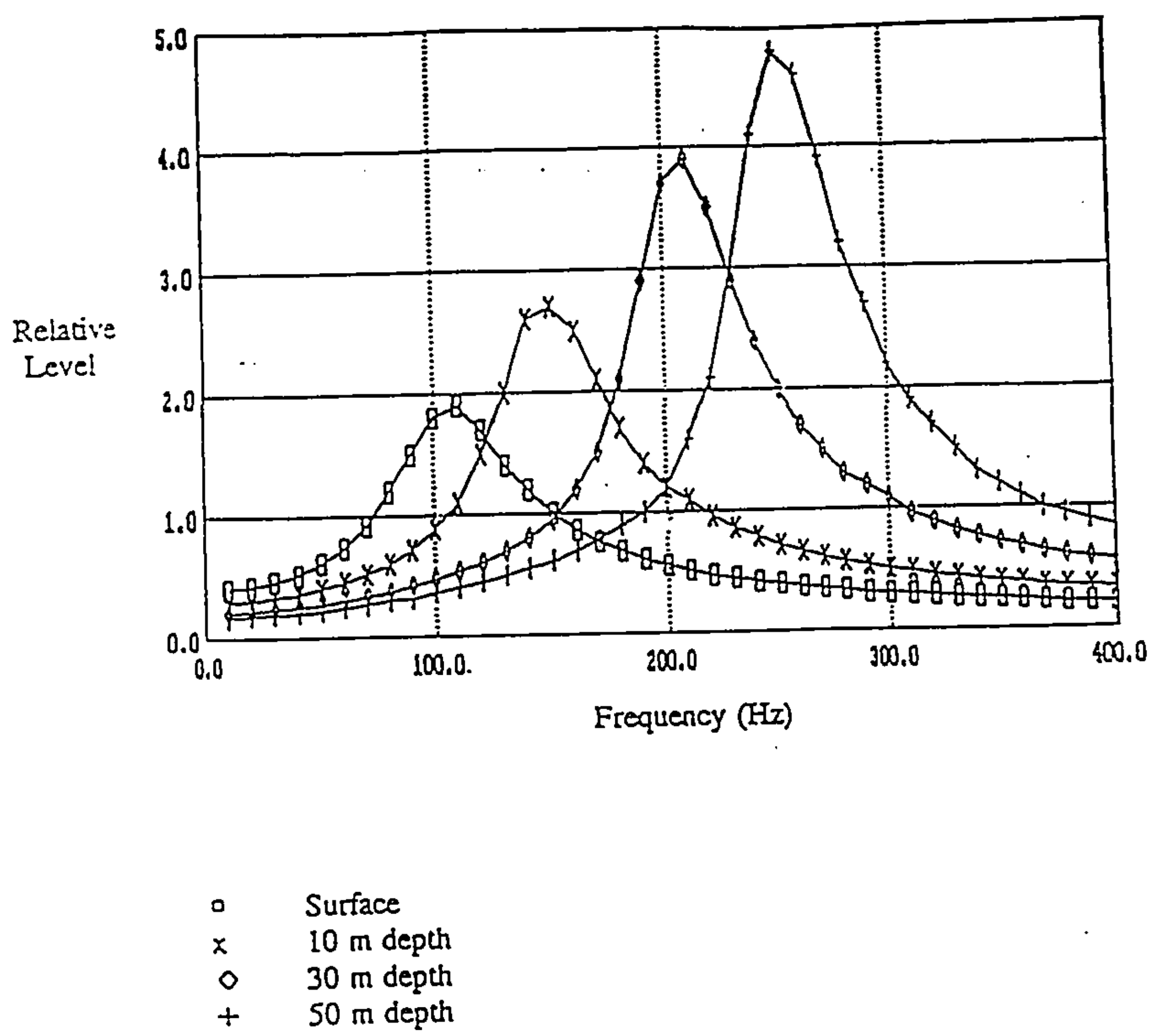


Figure 4.5.1.1-2 Estimated ratio between intrathoracic pressure and incident pressure (from Young, 1985).

about 20 Hz at 160 dB source level, and corresponded to the classic thoracic resonance. At higher frequencies at the same source level, no repeatable effects were observed other than a sensation of loudness.

With this information, the question of whether there would be any possibility that the proposed acoustic source transmissions could cause resonance of diver air-containing cavities can be addressed. At the surface, 20 Hz and 100 Hz appear to be the critical frequencies, the former for potential intrathoracic resonance, and 160 dB can be considered to be the level that could potentially cause hazardous disturbance to divers. The proposed source transmissions, which would be on a maximum of 8% of the time, would have a center frequency 55 Hz higher than the 20 Hz level, and 25 Hz lower than the 100 Hz level. The following summarizes the differentials between the proposed received values and the data presented:

	CRITICAL FREQUENCIES	PROPOSED FREQUENCY (difference in center frequency)	CRITICAL RECEIVED LEVEL	MAXIMUM RECEIVED LEVEL (DIFFERENCE)
SURFACE	20 Hz 100 Hz	57.5-92.5 Hz (+55 Hz) 57.5-92.5 Hz (-25 Hz)	160 dB	135 dB (-25 dB)
30 m DEPTH	40 Hz 200 Hz	57.5-92.5 Hz (+35 Hz) 57.5-92.5 Hz (-125 Hz)	160 dB	136.6 dB (-23.4 dB)
50 m DEPTH	50 Hz 250 Hz	57.5-92.5 Hz (+25 Hz) 57.5-92.5 Hz (-175 Hz)	160 dB	137 dB (-23 dB)

Given the above evidence, plus the fact that ATOC source energy is spread across a 35 Hz bandwidth, not concentrated in a narrowband tone as the stated experimental data were, it is safe to conclude that the potential for the proposed source causing resonance of any diver air-containing cavities would be negligible.

Potential Impact on Mechanoreceptor Cell Function

Mechanoreceptors (skin nerve fibers) can be classified as displacement, velocity, or acceleration detectors. They can be fatiguing or non-fatiguing. That is, they can become saturated and fail to respond to an above-threshold stimulus, or they can always respond to an above-threshold stimulus. There are only two acceleration mechanoreceptors in the human body, and only one of them is non-fatiguing--the Pacinian corpuscle. These then appear to be the receptors that would logically be associated with a vibration-produced response throughout the body when exposed to waterborne low frequency sinusoidal excitation.

The Pacinian corpuscle receptors are free floating and deeply buried in the skin, designed to respond to vibrations, while not responding to either steady pressure or constant velocity. They are distributed throughout the body in such a manner as to appear to serve a tactile and vibration sensing function. Their neural interconnections to the central nervous system are such that they override displacement sensors while lowering the threshold on acceleration sensors. Pacinian corpuscles are tuned to frequencies of 150-300 Hz, but respond to frequencies in the range of 60-900 Hz (Woolley and Ellison, 1993). They have an "all or none" nerve impulse, and respond to vibrations whose peak displacements are as small as 1 μm. The response of a Pacinian corpuscle to two or more non-co-located pressures is to sum them.

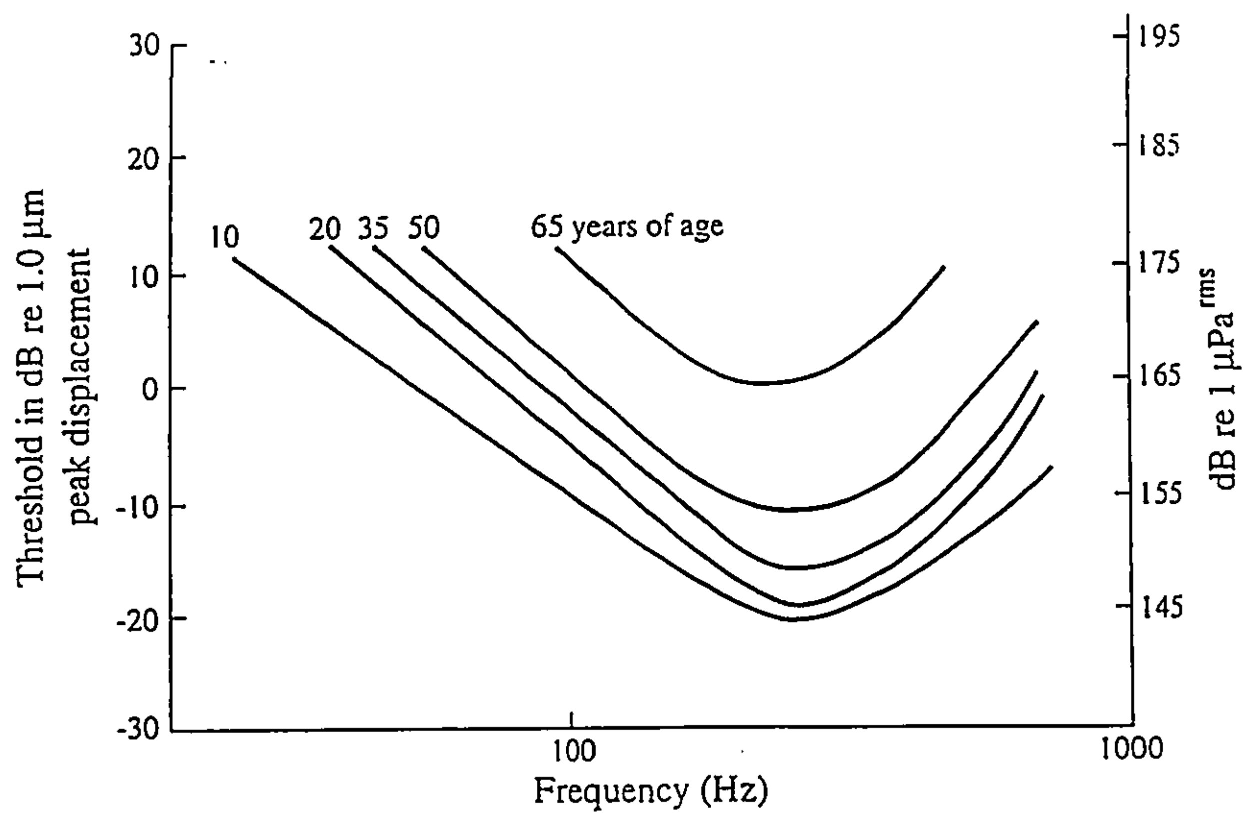
The frequency response curves of Pacinian corpuscles in some mammals (e.g., cats) are known to scale according to resonances in extremities (Woolley and Ellison, 1993). This lends strength to the argument that they are meant to respond to possibly harmful and, certainly, meaningful vibrations. The waterborne path of excitation of the Pacinian corpuscles of a diver may be considered an unusual one from the physiological viewpoint. The good fluid coupling will simultaneously allow excitation of Pacinian corpuscles throughout the body. Their neurological response of lowering the threshold of the acceleration receptors and sustaining the lower threshold could potentially contribute to additional sensations felt by a diver exposed to low frequency transmissions. It is fairly certain that the Pacinian corpuscles themselves are not being damaged, nor are they sensing damage. The noci receptors are the damage sensors and they are not at all excited by the sound levels being considered here.

If tactile and/or vibratory sensations felt by a diver were due to Pacinian corpuscle excitation, it seems logical that a very conservative criterion for in-water acoustic received level would be the Pacinian corpuscle threshold itself. Thus, if the Pacinian corpuscle could not "detect" the acoustic excitation, it can be considered to be at a safe level. In Figure 4.5.1.1-3 the threshold of the Pacinian corpuscle is plotted for humans. This is the minimum received level (right ordinate axis) necessary to just cause the Pacinian corpuscle to respond with a nerve impulse. The threshold is indicated by a line for each of the ages of the human in question (10, 20, 35, 50, 65 years of age). Note that at 75 Hz, for a 20 year-old, the threshold is approximately 165 dB. For a diver to be exposed to this received level from the proposed ATOC source transmissions, he/she would have to be within 30 m of the source at depth greater than 820 m. Therefore, it can be concluded that the potential for the proposed source causing any direct or indirect impact on humans' mechanoreceptor cell function would be virtually zero.

Potential Human Acoustic Annoyance

Most human diving activity off the north Kauai coast takes place within 2 km of the shoreline. As previously stated the minimum audible human threshold in water at 75 Hz is estimated to be about 108 dB. Based on the best FEPE acoustic performance prediction computer modeling available, the possibility of ATOC sound signals incurring the level of transmission loss that would allow a received level of 108 dB to reach to within 2 km of the shore is uncertain. The interference caused by the intense bottom and surface interaction of the sound rays as they travel from the ATOC source upslope into the shallow water nearshore regions will tend to cause cancellation and degradation of the sound field.

The possibility of a diver being exposed to a received level loud enough to hear it is moderate. Add to this the fact that the source would be operating only 2%-8% of the time (mostly 2%), and the potential for any human acoustic annoyance is anticipated to be low. Local diving organizations, and the local chapters of the Professional Association of Dive Instructors (PADI) and the National Association of Underwater Instructors (NAUI) would be contacted to help assess whether any divers hear, or are acutely or chronically annoyed, by ATOC emissions.



(from Kenshalo, 1978)

Figure 4.5.1.1-3 Threshold dependence of Pacinian corpuscles

If it is verified that substantial annoyance occurs that is directly relatable to ATOC source transmissions, operations would be temporarily suspended pending discussions with NMFS, MMRP AB, MMC, and the Kauai CAG.

4.5.1.2 Potential Cumulative Effects on the Human Environment

The following refers to only those alternatives that would affect the human environment in the Kauai, Johnston Atoll, Adak, or deep water moored autonomous source areas.

• Population dynamics: Because there would be no potential direct or indirect effects expected, no potential cumulative effect on population dynamics would be expected due to any of the alternatives being implemented.

• Educational institutions: Based on the proposed action's plans, the potential for any cumulative effect on educational (and environmental) establishments would be expected to be only positive in nature.

•Recreation and leisure activities: The potential cumulative effects of the alternatives on mysticete, odontocete, pinniped, or sea turtle watching, and sport fishing have been addressed previously. The section above concluded that the potential direct and indirect effects on human diving activities would be virtually zero. Therefore, it should be considered that any potential for any alternative altering the cumulative effects on human divers in the future would also be negligible.

4.6 OTHER POTENTIAL IMPACTS

Although potential habitat and biological resources impacts are the principal area of concern and the focus of this EIS, a number of other potential impacts are presented by the proposed project and its alternatives. These include vessel and aircraft traffic (MMRP activities), construction impacts (laying cable, installing the source, etc.), consistency with land use plans and policies (discussed below in Section 5), cultural and historical resource impacts (potential presence of shipwrecks, etc., at the facility site), visual impacts, employment, population and public services (researchers and others doing work on Kauai), air pollution (from vessel and aircraft activities), energy impacts (discussed in Section 6.3), hazardous materials and wastes (battery usage on moored autonomous sources), and cumulative impacts of the proposed action.

These additional impacts are each discussed briefly below. Where applicable, the impacts presented by alternatives will also be addressed. Except where otherwise noted, additional impacts from the no action alternative are assumed to be nonexistent. Any additional mitigation measures are identified.

4.6.1 POTENTIAL INCREASES IN VESSEL AND AIRCRAFT TRAFFIC

A project will generally be considered to have major transportation impacts if it will add measurably to existing traffic levels, or add to traffic levels that currently exceed system capacities. Currently, small vessels and aircraft operate in the vicinity of the proposed action site, but those traffic levels are well below the carrying capacity of local waterways and airways.

During the MMRP, minor increases would occur in vessel and aircraft traffic off the north Kauai coast (maximum total 30 days of flight operations and 90 days of vessel operations). Since the source would be powered from shore, it would not require maintenance that would result in increased vessel trips. All ATOC and MMRP vessel and aircraft trips are well within the capacity of the local waterways and airways, and do not constitute a significant impact.

The moored autonomous source alternative (Alternative 4) would result in greater levels of vessel traffic than the preferred alternative, since supply and maintenance trips would need to be made from some distance; however, that traffic would mostly occur at locations some distance from inhabited areas; i.e., on the high seas. Since the logistics of aerial MMRP observations would likely prove prohibitively difficult for the moored autonomous source alternative, that alternative could result in lower aircraft traffic than the preferred alternative, but that reduction would come at the expense of the MMRP.

Mitigation Measure 12-1: Vessel and aircraft traffic would be kept to a minimum, consistent with the requirements of the MMRP protocols and ATOC program requirements. Where possible, trips would be consolidated or other measures taken to reduce the aircraft and vessel traffic levels resulting from the project.

4.6.2 POTENTIAL DIRECT CONSTRUCTION AND MAINTENANCE IMPACTS

The ATOC source was constructed in Seattle, Washington and would be transported to the source site. Other than minor vessel traffic and resulting air pollution, installation and maintenance of the source are not anticipated to result in any environmental impacts. No alteration to the seabed will occur.

As described in Section 1, as part of the proposed project, a number of existing subsea listening facilities in various eastern and North Pacific Ocean locations would be modified and, where necessary, refurbished to be used as receiver sites. None of the work on these existing stations should have any environmental impacts, since no new facilities will be constructed, and all of the improvements are to or within existing structures, rights of way, or equipment.

The proposed project would also install up to two autonomous VLA passive listening arrays at other Pacific locations. They are powered by battery packs, but have relatively small power requirements (as compared to Alternative 4, Moored Autonomous Sources), such that the risk from leakage of battery fluids should be very minor.

Construction and operation of moored autonomous sources would likely have somewhat greater construction and maintenance impacts, due to the longer travel distances from the staging location that would be required.

4.6.3 CULTURAL AND HISTORICAL RESOURCES

Federal law, 36 C.F.R., Part 800, provides that environmental analyses need only consider impacts on primary cultural resources, defined for purposes of this EIS as resources listed on the National Register of Historic Places, eligible for listing in the National Register, or designated as a National Historic Landmark. A project will generally be considered to have an impact on cultural and historical resources if it would disrupt or adversely affect a prehistoric or archaeological site, a property of historic or cultural significance to a community or ethnic or social group, a paleontological site, or a local landmark of local cultural/historical importance.

A serious adverse impact would occur where there is a "substantial adverse change" such as demolition, destruction, relocation, or alteration activities that would impair the significance of the historic resource.

As described in Section 3.4.6, a literature and archival review was performed for the proposed project area off the north shore of Kauai and off Johnston Atoll. No impacts to prehistoric or cultural resources are anticipated.

Some shipwrecks are recorded in the general vicinity of the north Kauai offshore area and in the vicinity of Johnston Atoll (see Section 3.4.6). The precise locations of most of these are unknown. However, the immediate area of the Kauai source site has been thoroughly studied and no shipwrecks are located within at least 10 km radius. Baseline analysis of the Johnston Atoll site alternative also reveals no known shipwrecks within at least a 10 km radius.

4.6.4 POTENTIAL VISUAL IMPACTS

Visual impacts are generally considered serious if they violate applicable guidelines relating to visual quality, critically alter the existing natural views including changes in natural terrain, or if they seriously change the existing visual quality of the region or eliminate visual resources.

Since all Kauai onshore facilities will be either underground or in existing buildings, no visual impacts will result. Furthermore, the source power cable is tied into an existing Navy cable, such that there is no additional visual impact. For the Johnston Atoll alternative, the only potential visual impact would be related to the section of the cable, enclosed by pipe, from the surf line to the landfall, which would be considered to be minimal, given the minor scope of the facilities and the existing setting.

4.6.5 EMPLOYMENT, POPULATION, AND PUBLIC SERVICES

A project generally will be considered to have a major impact on population, employment and housing if it will induce substantial growth or concentration of population, displace a large number of people, or conflict with the housing and population projects and policies set forth in applicable land use plans. The MMRP research team consists of no more than 20 personnel at any time, most of which are either affiliated with, or stage their research efforts from the University of Hawaii. In comparison to the overall level of employment opportunities in Hawaii and Johnston Atoll, and current population levels, this additional employment and population is minor. In addition, no measurable effects on public services, such as police, fire protection, schools, and housing, are anticipated to result from the proposed project.

4.6.6 POTENTIAL AIR POLLUTION

A project will be considered to have a serious impact on air quality if it will cause or contribute substantially to existing or projected air quality violations, or result in the exposure of a sensitive population to substantial pollution concentrations. Generally, air quality in the vicinity of the proposed project is good to excellent. All vessel and aircraft traffic associated with the project will generate some air pollution, but at levels well below those that would cause or contribute to air quality violations. In the worst-case scenario, two vessels and two aircraft would be conducting research operations simultaneously, but their combined emissions would not exceed 150 lb/day of ROG or NOX.

All other alternatives, except the no project alternative, would have similar air pollution impacts when compared to the preferred alternative. Locating the source site at Johnston Atoll would also involve use of vessels to support activities at this location, with comparable air pollution impacts. The use of moored autonomous sources, which would require servicing by vessels at more remote locations, would increase air pollution impacts. Since this air pollution would occur at locations where current air quality conditions are good to excellent, no adverse effects would be expected to result from either alternative.

Mitigation Measure 13-1: All ATOC/MMRP vessels and aircraft would be equipped with required air pollution controls.

4.6.7 POTENTIAL HAZARDOUS MATERIALS AND WASTES

The proposed source and cable installation involves no use of hazardous materials and will not produce any hazardous wastes. The MMRP will not use hazardous materials or generate any hazardous wastes.

Moored autonomous sources would need to be powered by batteries which, if they were to leak or if recovery of the sources could not occur at the end of their useful lives, could add minor amounts of hazardous materials to the marine environment. However, any toxic discharge should be neutralized quickly in seawater.

4.6.8 POTENTIAL CUMULATIVE IMPACTS OF THE KAUAI AND PIONEER SEAMOUNT PROJECTS

No direct physical cumulative impacts of the proposed Pioneer Seamount and Kauai ATOC sources would occur. Those facilities are independent and separated by a distance greater than 3700 km. The sound sources at Kauai and Pioneer Seamount are not planned to be operated concurrently, but the minimum range at which a marine animal might be exposed to both source transmissions sequentially would be 1850 km from either source. At that range, the received sound levels should be on the order of 85 dB in the deep sound channel, and 88 dB at 100 m depth (based on FEPE transmission loss calculations and estimated attenuation values due to absorption and thermal discontinuities [e.g., ocean fronts and eddies] from the 1991 HIFT and the 1994 AET), which are within the range of ambient noise conditions an animal would normally be subjected to in the open ocean. It should be noted that ambient noise conditions in the deep sound channel (800-1000 m depth in the study area) are approximately 2-3 dB lower than near the surface (Morris, 1978).

Only migrating species would have any potential for direct cumulative impacts as a result of the two sources. The only species that might migrate between these two sites is the humpback whale. This could possibly occur with animals that summer offshore California and winter in Hawaii. However, it is generally believed that one or more groups of humpbacks move directly between the Hawaiian Islands and the Aleutian Islands/Gulf of Alaska; and one or more groups move between Mexico and the Gulf of Alaska (via California waters) (Winn and Winn, unpub.). Thus, the potential for cumulative effects on the same population would be expected to be negligible.

In the event that similar impacts to different populations of the same species at both locations were to occur, this could be considered a cumulative impact to the species as a whole. The MMRP is intended to determine whether potential impacts to habitats or biological resources may occur. Any cumulative impacts to separate populations of species at the two sites would be mitigated through measures at the respective sites.

5 CONSISTENCY WITH FEDERAL, STATE AND LOCAL REQUIREMENTS, PLANS AND POLICIES

This section addresses the federal, state and local permitting and other regulatory requirements that do, or may, apply to the Kauai project. This section also analyzes the MMRP in relation to applicable plans and policies, including the Hawaii Coastal Zone Management Program, the Ocean Resources Management Plan, and the Humpback Whale Recovery Plan.

All project facilities and activities will comply with all applicable federal laws and regulations and with applicable regional, state, and local land use plans, policies, laws and regulations. Scripps is the applicant for governmental approvals and is the coordinator of the overall program. Cooperating institutions include, among others, the Cornell University Bioacoustic Research Program and the University of Hawaii.

The regulatory programs applicable to the project are summarized below.

REGULATORY PROGRAM	AGENCY RESPONSIBLE	TIMETABLE AND STATUS
MMPA/ESA Scientific Research Permit	NMFS	Submitted on 12/23/94, Pending
ESA Section 7 Consultation	NMFS	Consultation requested 6/17/94. Pending, processing concurrent with EIS
Rivers and Harbors Act Section 10	U.S. Army Corps of Engineers	Nationwide permit notification on 8/29/94
Hawaii Coastal Zone Management Program, federal consistency review, 16 U.S.C. § 1456(c)(3)	Hawaii Office of State Planning	Consistency Certification submitted 1/25/95; pending
Conservation District Use Permit	Hawaii Department of Land and Natural Resources	Application accepted 10/3/94, Pending

This section first considers federal regulatory requirements, including the Scientific Research Permit (SRP) under the MMPA and ESA, consultation under Section 7 of the ESA, and authorization under the Rivers and Harbors Act nationwide permit program. This section next considers State of Hawaii regulatory programs, including conservation district use regulation and federal consistency review by the state under the federal Coastal Zone Management Act, as well as other resource management programs including regulation of water quality and noise pollution by the state Department of Health (DOH). This section then reviews the project's relationship to applicable plans, policies, and potential future programs.

5.1 FEDERAL REGULATORY PROGRAMS

This subsection describes the federal regulatory programs that apply to the Kauai MMRP, including the scientific research permit process administered by NMFS, Section 7 consultation under the Endangered Species Act, and Section 10 of the Rivers and Harbors Act.

5.1.1 MARINE MAMMAL PROTECTION ACT AND ENDANGERED SPECIES ACT: SCIENTIFIC RESEARCH PERMIT

A principal use of this EIS will be to support consideration of an SRP under the MMPA and ESA. Key requirements for an SRP are listed here:

- The proposed taking is for purposes of scientific research.
- The proposed taking has been reviewed by the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals.
- The proposed taking is required to further a *bona fide* scientific purpose.

Other requirements for issuance of SRPs are set forth in regulations adopted by NMFS under the MMPA and ESA. Scripps's application for an SRP for the Kauai MMRP is pending.

5.1.2 ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

Consultation under Section 7 of the ESA is required for this project. Section 7 consultation is the process by which federal agencies coordinate with NMFS (or, for many species, the U.S. Fish and Wildlife Service) to ensure that no jeopardy to endangered species or adverse modification to habitat will result from federally initiated, funded, or permitted activities. By letter dated June 17, 1994, ARPA requested consultation in accordance with Section 7.

The responsibility for Section 7 consultation rests with NMFS for certain species that are under its ESA jurisdiction. Endangered species potentially affected by the Kauai MMRP and acoustic thermometry project are limited to species regulated by NMFS.

The consultation process centers around a biological assessment. As permitted by the Section 7 regulations, this EIS contains the analysis and information necessary to support Section 7 consultation, and is intended to serve as the biological assessment for that consultation.

NMFS will issue its findings regarding the Section 7 consultation based on the information presented in this EIS.

5.1.3 RIVERS AND HARBORS ACT SECTION 10

The Kauai installation would include a sound source located offshore 14.7 km north of Haena Point on the north shore of Kauai and a subsea power transmission cable which connects to an existing cable approximately 1.3 km offshore Barking Sands, and follows a 51.5 km course around the northwest side of the island to the source site.

The U.S. Army Corps of Engineers has been consulted concerning permitting requirements. Some or all of these facilities require authorization under Section 10 of the Rivers and Harbors Act because they are considered by the COE to be structures and involve work in navigable waters of the U.S. Notification of use of Section 10 nationwide permits #5 and #6 was given on August 29, 1994. The COE confirmed that the permit program of Section 404 of the Clean Water Act does not apply to this project. Section 404 only applies within the three-mile sea and the only project components within that area are portions of the cable. Because no trenching or alteration of the seabed is involved in laying of the cable, and the cable itself is not considered by the COE to constitute fill, no Section 404 permit is required.

5.1.4 COASTAL ZONE MANAGEMENT ACT SECTION 307 COORDINATION AND COOPERATION

The Federal Coastal Zone Management Act (CZMA, 16 U.S.C. Section 1451 et seq.) establishes a voluntary program for states to develop coastal management programs. Once such a program is federally approved, all federal actions affecting the coastal zone must be consistent with the enforceable policies of a state coastal management program. Direct federal actions must be consistent to the maximum extent practicable. Activities requiring federal licenses or permits, or federal assistance to state or local governments must be fully consistent. This federal consistency requirement applies to federal actions affecting the coastal zone, regardless of whether they will occur within or outside of the coastal zone. It also ensures that federal agencies and federal permit applicants coordinate and cooperate with state coastal management agencies. Following the agency's consistency determination or applicant's consistency certification, the state coastal management agency then reviews the activity for consistency with the state coastal management program.

5.2 REVIEW BY THE STATE OF HAWAII

This section considers state regulatory programs that apply to the proposed project facilities and activities in and around the state. These programs are the federal consistency review conducted by the Office of State Planning under the federal Coastal Zone Management Act and State coastal zone management authorities, and the Conservation District Use Permit program administered by the Department of Land and Natural Resources. The water quality certification program, carried out by the Department of Health, and water quality authorities, are also considered.

Beginning in May of 1994, Scripps representatives met and conferred with representatives from a number of state agencies, including DLNR, OEQC, OSP, and DOH, concerning regulatory requirements applicable to the MMRP and acoustic thermometry project. Discussions were also held with State Historic Preservation and Aquatic Resources Divisions of DLNR. Additional consultation with these agencies has continued. On the basis of these discussions, an application for a Conservation District Use Permit was submitted to DLNR on August 3, 1994, which was accepted for formal consideration on October 3, 1994. This and other relevant regulatory authorities are discussed below.

5.2.1 COASTAL ZONE MANAGEMENT PROGRAM: FEDERAL CONSISTENCY REVIEW

Hawaii's coastal zone management program (CZMP) has been approved under the Federal Coastal Zone Management Act of 1972. The state thus has authority under the Act to review federal activities and federally approved and funded activities which affect the state's coastal zone for consistency with the Hawaii CZMP. The program includes applications for permits under the Marine Mammal Protection Act and Section 10 of the Rivers and Harbors Act among those subject to consistency review.

Hawaii's CZMP is administered by the Office of State Planning (OSP). The state's CZMP contains seven resource categories, each including a set of objectives and policies, and each drawing upon a network of laws administered by other agencies. Further discussion of CZMP network agencies and authorities appears at Section 5.2.2. The OSP consistency review process provides an opportunity for review and input by those agencies, with the state consistency decision being rendered by the OSP.

Scripps has prepared and submitted to OSP a certification of the project's consistency with the Hawaii CZMP. The certification was submitted to OSP on January 25, 1995, and the six-month review period is underway. The certification is supported primarily by this EIS and supplementary information submitted to OSP.

Recreational Resources

Objective: Provide coastal recreational opportunities accessible to the public.

Relevant policies implementing this objective focus on coordination of coastal recreation planning and management, and providing coastal recreational opportunities by protecting coastal resources important to recreation, including shoreline parks, water quality, and use of waters suitable for recreation. As discussed below, the project is consistent with these provisions.

At least three whale-watching boats operate off Kauai where some humpback whales wintering in Hawaiian waters may be seen close to shore between November and April. As discussed in Section 4.4, the proposed project is not expected to have any negative impacts on recreational viewing or photographing of humpback whales, provided the scientific assumptions declared in this EIS are correct. However, some uncertainty exists concerning potential effects on certain species, including sperm and beaked whales. If whales were to alter their courses to avoid the sound field--an effect considered uncertain--whale-watching activities in the area could be affected. See Section 4.4.1.

During the MMRP, humpback whales would be closely monitored for any potential effect of the sound transmissions on their movements and behavior. Monitoring activities would include visual surveys from shore and by air and boat, and underwater acoustic monitoring of transmitted sound fields and whale vocal patterns.

None of these activities are expected to have a negative impact on the whales, to the extent that they would alter their normal use of the Kauai waters, provided the scientific assumptions declared in this EIS are correct. If any acute or short-term effect (Appendix C) is observed that is attributable to source transmissions, the transmissions would be terminated pursuant to the research protocols attached as Appendix C. Thus, no negative impacts on recreational whale-watching are expected to occur.

The proposed project is not expected to have any negative impacts on recreational divers. The sound transmissions would be in a low frequency range similar to a low rumble. As is detailed in Section 4.5.1, for the sound transmissions to be loud enough to potentially cause any negative physical impacts on human hearing a diver would have to be within touching distance of the sound source. Since the source is located on the ocean bottom at approximately 850 m, this is essentially impossible. By extrapolation of available human underwater hearing threshold data (Hamilton, 1957; Smith, 1965; Hollien et al., 1967) down to 75 Hz, the minimum audibility level of 108 dB is derived -- a level that would seldom be exceeded at local diving locations, which are mainly close to shore. Therefore, it is expected that few, if any, divers would hear the source transmissions. Hollien (1993) suggests that the dynamic range of human hearing underwater may be lower than that assumed in this EIS, which is based primarily on in-air hearing. If a lower value is appropriate, then the underwater received level that could cause TTS could be less than the assumed 188 dB. Conversely, if the dynamic range is higher, the underwater level that could cause TTS would be higher than the assumed 188 dB.

Acoustic sources and receivers, associated cables, and the transmission of underwater signals would all occur approximately 14.7 km off the north coast of Kauai and along the offshore cable route, and would not be near or interfere with any State or County park, dedicated public right-of-way, perennial stream, sandy beach, or swimming or surfing area, and would not affect the shoreline.

Information obtained from the research program on marine mammal reactions to subsea noise has the potential to inform management decisions needed to implement measures to protect coastal parks and beaches. The proposed research would be expected to contribute to understanding of ocean climate changes, which may assist in shoreline management decisions designed to protect recreational beaches. The loss of island beaches due to erosion was documented in a 1992 study prepared for the Hawaii Coastal Zone Management Program, Beach Management Plan with Beach Management Districts (Hwang and Fletcher, 1992). Sea level rise, which may be linked to ocean climate change, was identified as a possible cause. See discussion under "Coastal Hazards," below.

Historic Resources

Objective: Protect, preserve, and where desirable, restore, those natural and man-made historic and pre-historic resources in the CZM area that are important in Hawaiian and American history and culture.

The proposed project would have no foreseeable impact on historic or pre-historic cultural resources.

The sound source would be contained in a 3.5 m-high galvanized steel tripod frame which would sit on the ocean floor at a depth of 850 m, 14.7 km north of Haena Point. The power cable is on the ocean floor in deep water along the northwestern side of the island from a seafloor connection offshore from Barking Sands to the source site. The placement of the source and cable does not require any excavation or modification of the sea bottom.

The proposed project site is not located within a historic/cultural district, nor is it listed on or nominated to the Hawaii or National Register of historic places. The proposed project will not be within or near a Hawaiian fishpond or historic settlement area.

Although shipwrecks are thought to be present along the northern Kauai shore, a side-scan sonar survey for the location of the cable and sound source did not reveal the presence of any shipwrecks or other historic or archeological resources on the ocean floor. See also discussions at Sections 4.6.3 and 5.2.2.2. The State Historic Preservation Division has stated that due to the location of the project, it is expected to have no effect on significant historic sites (Appendix D).

Scenic and Open Space Resources

Objective: Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

The proposed project would not alter any visual or scenic resources or public views along the shoreline.

The project consists of the placement of cables and a sound source on the ocean floor, after which none of the equipment would be visible above water. No construction would occur onshore or in or on waters seaward of the shoreline. Accordingly, no component of proposed action would abut a scenic landmark or would be adjacent to an undeveloped parcel nor would it be visible between the nearest coastal roadway and the shoreline.

The MMRP would involve a slight temporary increase in boat and airplane traffic which would be visually indistinguishable from the current uses of the project area.

Coastal Ecosystems

Objective: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

This CZMP objective and the relevant implementing policies call for preserving coastal ecosystems, promoting water quality planning and management, and improving the technical basis for natural resource management. [The coastal (or neritic) zone is scientifically defined as the pelagic environment above the continental shelf; it is legally defined by HEPA as that region seaward to the limit of the State's jurisdiction.]

As discussed in Section 4.3, the proposed project is not anticipated to result in reasonably foreseeable adverse effects on biological resources. Accordingly, the proposed project is not expected to adversely affect coastal ecosystems. Section 4.3 notes that information is scarce concerning the degree to which subsea sounds in the low frequency range could potentially affect marine animals. The MMRP is designed to help close this gap in information and to provide for termination of the transmissions if acute or short-term effects (Table C-1) are detected.

As more fully described in Section 3.3.7, the proposed project would be located generally within the broad range of the following federally-listed endangered species: humpback whale (*Megaptera novaengliae*), sperm whale (*Physeter macrocephalus*), Hawaiian monk seal (*Monachus schauinslandi*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), and olive ridley sea turtle (*Lepidochelys olivacea*); and the following threatened species: loggerhead sea turtle (*Caretta caretta*) and Hawaiian green sea turtle (*Chelonia mydas*); and the following Hawaii-listed threatened or endangered species: right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), and the green sea turtle (*Chelonia mydas*). The physical components of the project -- source, receivers, cables -- would not cause any impact to the habitat of these species. The sound transmissions could potentially affect those species which would be within the source sound fields and are capable of hearing low frequency sounds below 90 Hz. The potential impacts of the sound transmissions on the marine animal species in the area, including threatened and endangered species, are discussed in Section 4.3.

The proposed project would not degrade coastal waters. It does not involve any earthwork or dredge or fill activities. It would not be located within the Shoreline Setback Area, Marine Life Conservation District, or Natural Area Reserve, nor are there any intermittent or perennial streams or estuaries located on or near the project site. Of the marine bottom ecosystems identified in the state's water quality standards, only soft bottom communities occur along the cable route, and the relevant standards are satisfied by the project. See Section 5.2.3.

The proposed project would not include the construction of any special waste treatment facilities nor require effluent discharge into water. None of the components of the project would require the use or discharge of any hazardous or nonhazardous material.

The proposed MMRP would provide needed scientific data on the coastal marine ecosystem, and the acoustic thermometry studies would provide data on ocean climate, which affects coastal ecosystems. These data would be available to resource management agencies, as well as educational and scientific institutions and the public. The information obtained by this project has the potential to improve the technical basis for resource management decisions.

Economic Uses

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

This CZMP objective and its implementing policies focus on concentration of coastal-dependent development in areas designated for such use when feasible or, when not feasible and when the development is important to the state's economy, allowing location in other areas, provided that adverse environmental effects are minimized.

The proposed ATOC and MMRP facilities and activities are coastal-dependent and require an in-ocean location. By connecting to an existing seabed power cable, the project would avoid the need to place another shore-to-sea cable installation. The proposed location of the sound source and associated cable north of Kauai is dictated by depth requirements, the need for clear acoustic paths, suitable marine animal study populations, and other factors discussed in Section 2.2.3.1. These siting needs make it infeasible to locate the project in an area where other coastal-dependent activities are concentrated. however, the project would be located on submerged lands designated Conservation District, Resource subzone, and the proposed uses are consistent with uses allowed in those areas. See Section 5.2.2.

To the extent that the CZMP calls for examination of the development's importance to the state economy and the minimization of adverse effects on the environment, the following considerations are relevant.

The direct economic effect of the project would occur primarily through employment of Hawaiian personnel and purchases of supplies and services during the course of the project. From 10 to 20 scientists, most from the Hawaii marine science community, would be involved in visual and aerial observations as part of the MMRP. Local marine support and maintenance services and other research resources would be utilized by the project. A Hawaii-based vessel would be chartered for trans-Pacific cruises to correlate acoustic data with spot measurements along actual acoustic paths. Local vessels have already been utilized to conduct a sonar survey to identify suitable locations for the cable and sound source. During 1993 the M/V NA'INA was chartered from Uaukewai Diving Salvage and Fishing, Inc., and the research vessel KILA was chartered from the University of Hawaii for this purpose.

The project's longer-term economic importance to the state lies in its furtherance of the states policy of fostering research and education based upon Hawaii's natural ocean laboratory. See Section 5.3.1. The acoustic thermometry and marine animal research could attract other ocean research and education activities to Hawaii. Any such effect is uncertain and cannot be quantified at this time.

As discussed elsewhere in this EIS, the project is expected to have no significant adverse impacts on the environment. There is some potential for effects on the biological environment. See Section 4.3. Through implementation of the MMRP, including 23 mitigation measures, and the research protocol, the risk of such impacts has been minimized, consistent with this CZMP policy. See Section 2.2.1 and Appendix C.

Coastal Hazards

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

This objective and the implementing relevant policies focus on reducing coastal hazards by developing and communicating information on ocean climate-related factors, including flood, erosion, and subsidence hazards, ;which jeopardize development along Hawaii's coasts. Other policies concern avoidance of locating development in hazardous areas.

If warming of the earth's climate is underway, rising sea level can be expected, resulting in flooding and erosion in coastal areas. However, the question of whether global warming is underway is complex and controversial. See Section 1.1.1. Computer models of global warming have had to rely on assumptions, rather than actual measurement, of ocean temperatures on a basin scale. The models and their projections have thus been subject to criticism and have not provided a compelling basis for formulation of policy for dealing with global climate change issues.

Acoustic thermometry of ocean basins would provide the precise temperature measurements needed for effective computer modeling of global climate change. The Kauai project would test the operational feasibility of this concept. The project would thus be consistent with the CZMP policy concerning development of information on ocean climate-related hazards. Given the nature of project facilities and their location entirely offshore in deep water (850 m), siting of the project would present no conflict with policies concerning location of development away from areas prone to coastal hazards.

Managing Development

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

This objective and its implementing policies focus on the development review process, seeking to utilize law in managing coastal zone development, to facilitate timely processing, and to understandably communicate development impacts to the public.

The consistency review process is being carried out concurrently with other environmental review processes applicable to the project. These are the SRP application review by NMFS under the MMPA and ESA, ESA Section 7 consultation by NMFS, Rivers and Harbors Act Section 10 nationwide permit review by the U.S. Army Corps of Engineers, and Conservation District Use Permit review by the Hawaii Department of Land and Natural Resources (DLNR). The key environmental information and analysis for these processes is contained in this EIS, and the EIS also serves as the principal basis for the federal consistency certification. Accordingly, the requirements of the other relevant environmental laws are integrated into the analysis under the state and federal coastal zone management authorities.

Since shortly after receipt of an OSP request for a federal consistency certification, on May 10, 1994, Scripps has been in frequent contact with the Hawaii CZMP office to work out the details of a timely review process. Two meetings with CZMP staff were held in Honolulu in the spring and summer of 1994, followed by several telephone contacts. The consistency certification was submitted shortly after publication of the DEIS, which provided the basic information needed for CZMP review.

Other aspects of the regulatory review process began in the early stages of project planning. Scripps first submitted the application for an SRP to NMFS in October, 1993. After publication of notice in the Federal Register, public hearings on the application were held at NMFS, Silver Spring, MD (March 22, 1994), Honolulu (April 14, 1994), and Lihue, Kauai (April 15, 1994).

Notice of Intent to prepare an EIS was published in the Federal Register on April 15, 1994. After Scripps' submission of a permit application to DLNR, an EIS Preparation Notice was published in the Hawaii OEQC Bulletin of October 12, 1994. Comments from the public received by mail and at the hearings were reviewed and addressed in the DEIS. NMFS and ARPA conducted public hearings on the DEIS in Lihue (February 9, 1995) and Honolulu (February 10, 1995). Comments received at those hearings and through mail have been addressed and incorporated into this FEIS to facilitate decisions on Scripps' applications to NMFS and DLNR, and ARPA's decision on the project.

Through these means, Scripps has sought to provide timely and understandable information to the public about possible project impacts, consistent with these provisions of the CZMP.

5.2.2 CONSERVATION DISTRICT USE AUTHORIZATION: DLNR

Chapter 190D, Hawaii Revised Statutes, establishes a permit program within the DLNR for use of "state marine waters." The statute defines that term as waters "extending from the upper reaches of the wash of the waves on shore seaward to the limit of the state's police power and management authority, including the United States territorial sea." H.R.S. Section 190-1.5. The geographic extent of state marine waters has been subject to debate. State jurisdiction is recognized by the federal government extends to three nautical miles. For certain purposes of international law, the U.S. territorial sea has been extended by executive order to 12 nm. The

U.S. Exclusive Economic Zone (EEZ) extends seaward to 200 nm. The effect of these factors on claims regarding the state jurisdiction seaward of the islands remains unresolved.

The sound source and portions of the power supply cable lie seaward of the tthree-mile sea. Apart from considerations concerning geographic jurisdiction, and in recognition of the State of Hawaii's interest in the full range of the ATOC and MMRP research activities, Scripps has included in its application for the conservation district use permit the entire complement of facilities proposed to be used and the operations of both the MMRP and acoustic thermometry project.

The project is within the Resource subzone of the Conservation District. Under DLNR regulations, the Resource subzone objective is "to develop, with proper management, areas to ensure sustained use of the natural resources . . . " Hawaii Admin. Regs. Section 13-2-13. Under Chapter 2, Title 13 of the regulations, relevant permitted uses in the subzone are:

- Research, recreational, and educational uses which require no physical facilities;
- Establishment of marine, plant, and wildlife sanctuaries and refuges;
- Restoration or operation of important historic and archaeological sites listed on the national or state register;
- Maintenance and protection of desired vegetation;
- Programs for control of animal, plant, and marine population, to include fishing and hunting;
- Monitoring, observing, and measuring natural resources;
- Occasional use;
- Government use not enumerated herein where public benefit outweighs any impact on the conservation district;
- Emergency warning systems;
- Flood, erosion, or siltation control projects;
- Aquaculture;
- Artificial reefs;
- Commercial fishing operations.

Effective December 12, 1994, DLNR adopted Chapter 5, Title 13, which modifies permitted uses in the conservation district. DLNR has advised Scripps that the controlling regulations are those in effect at the time the permit application was submitted, so that the Chapter 2 permitted uses are determinative. However, the relevant provision of the Chapter 5 permitted uses are also included here.

Under Chapter 5, the resource subzone objective is unchanged. Relevant permitted uses, in summary, are:

- Data collection, research, education, and resource evaluation which does not involve a land use, which involves a land use with incidental disturbance from installation of equipment (e.g., rain gauges or meteorological towers), or involves a land use causing ground disturbances (e.g., exploratory wells).
- Aquaculture
- Artificial reefs
- Astronomy facilities
- Marine construction, dredging, filling on submerged lands
- Mining and extraction
- Moorings and aids to navigation
- Public purpose uses by the State of Hawaii or the counties to fulfill a mandated governmental function, function, activity, or service for public benefit and in accordance with public policy and the purpose of the conservation district. Transportation systems, public utility transmission facilities, and other such land uses undertaken by non-governmental entities which benefit the public and are consistent with the purpose of the conservation district.
- Sanctuaries
- Demolition, removal, alteration of existing structures, facilities, equipment.

The Board must find the project consistent with one or more of the allowed uses. The Board cannot approve an application unless it finds that: 1) the applicant has the capacity to carry out the entire project, and 2) the proposed project is clearly in the public interest upon consideration of the overall economic, social, and environmental impacts. Hawaii Revised Statutes Section 190-11(e).

The proposed project is consistent with several of the allowed uses in the Resource subzone under both the new regulations and the old.

Regarding the old (Chapter 2) regulations: The proposed project is a research and educational project and will require no permanent facilities. Both the MMRP and the acoustic thermometry involve the monitoring, observing, and measuring of natural resources. Given the low source duty cycle proposed to be used, the project is an occasional use. It is also an important government research project and, given the protections provided by the MMRP Pilot Study, anticipated benefits outweigh any potential impact on the conservation district.

Regarding the new (Chapter 5) regulations: Both the MMRP and the acoustic thermometry portions of the project involve data collection, research, education, and resource evaluation. Placement of the cable and source would constitute incidental disturbances similar to the placement of rain gauges or meteorological towers. The equipment would not be constructed on site, but would be placed there already constructed, and this is logically a lesser use included in the allowed use of "marine construction" on submerged lands. The project is designed to serve an important public purpose. Given its sponsorship by a federal agency and a relatively high level of participation of representatives of the University of Hawaii, this project may also fall under the "public purpose" provision of the Chapter 5 permitted uses.

This EIS and supplementary information provided to DLNR in conjunction with the permit application provides the foundation for substantive evaluation of the project by the Department's Office of Conservation and Environmental Affairs (OCEA) and the Board. Permit application review and action by the Board will bring together input from other state and local agencies with authority relevant to the project. Through conditions on any permit, DLNR can address concerns identified by these agencies. Among the agencies which may be involved are the Hawaii Department of Transportation which has jurisdiction relating to maintenance of navigation channels, the Department of Health which has state authority in relation to water quality, and the Divisions of Historic Resources Preservation and Aquatic Resources within DLNR.

5.2.2.1 Hawaii Department of Transportation

The Hawaii Department of Transportation (DOT) has jurisdiction over state submerged lands and must give approval for activities and installations which might interfere with navigation. Under Hawaii Revised Statutes, Chapter 266, this review occurs within the context of the DLNR permit review process. Given the depth at which equipment will be placed, it can be expected to have no effect on navigation. The DOT has notified OCEA that the project does not appear to have any discernible impact on the state's commercial harbor facilities or operations (Appendix D).

5.2.2.2 Division of Historic Resources Preservation, DLNR

Facilities and activities associated with the proposed action would be entirely in marine waters. The state's historic preservation program, which is carried out by the Division of Historic Resources Preservation within DLNR, includes no survey of shipwrecks or other possible historic resources in state marine waters. Program officials have been queried and have responded that they have no knowledge of such resources. DLNR has received no comments concerning possibly affected historic resources. The Division has notified OCEA that no field check is required because the Division believes the project will have no effect on significant historic resources due to its offshore location (14.7 km offshore). See Appendix D.

5.2.2.3 Division of Aquatic Resources, DLNR

Responsibility for management of state fisheries aquatic resources lies with the Aquatic Resource Division of DLNR. The Division has no direct permit requirements which affect this project. The Division has commented (Appendix D), expressing its support of research leading to greater knowledge of the ocean and its marine life, but questioning why additional ocean thermal data is needed. See Section 1.1.1. The Division has also commented that its fish aggregating device (FAD) north of Kauai is sufficiently distant from the proposed sound source site (approximately 16 km) to avoid interference with FAD anchors and cables. The Division states that it is unknown how the sound pulses may affect the behavior of fish around the FAD, because little is known about the potential effects of low frequency sound on fish. See Sections 3.3.3 and 4.3.2.2.

5.2.2.4 Division of Land Management, DLNR

A memorandum from this division states that inasmuch as the proposal does not affect present or future Land Management programs, the Division has no objections to the project (Appendix D).

5.2.3 WATER QUALITY AND NOISE REGULATION: DEPARTMENT OF HEALTH

Hawaii Department of Health (DOH) has authority in relation to aquatic resources under Chapter 342D, Hawaii Revised Statutes; Title 11, Chapter 54, Hawaii Administrative Rules (water quality standards); and other state authorities. Under Chapter 342F, DOH regulates certain noise pollution, not including noise in state marine waters. These statutes and rules are part of the state's Coastal Zone Management Program authorities network, and the DOH participates in implementation of these authorities through the federal consistency review process. Similarly, DOH implements the aquatic resource policies and standards through recommendations to DLNR on CDUP applications.

The DOH is also the state agency which implements water quality certification under Section 401 of the Clean Water Act, applying the state water quality certification standards. The authority for Section 401 review arises in connection with any federal permit for discharge into navigable waters of the United States (defined by Section 502(8) of the Clean Water Act to extend three miles seaward from the shore). Because no federal discharge permit is required for this project, the State has given notice that Section 401 certification is not needed. The State also has indicated that, given the uncertainty about potential effects of low frequency sound on aquatic life and the availability of findings on this issue at the conclusion of the MMRP, it is premature for DOH to make a determination regarding possible applicability of other water and noise-related authorities of DOH (Appendix D). DOH may reevaluate that question after reviewing the MMRP Pilot Study findings.

The state water quality standards of Title 11, Chapter 54, establish classifications for marine waters and marine bottom ecosystems and define compatible uses and criteria. All portions of the cable fall within the areas classified as "Open Coastal Waters" (shore to 183 m) or "Oceanic [deeper] Waters." Section 11-54-07. The cable route begins at a depth of 24 m offshore from Barking Sands, runs seaward around the northwest side of the island at depths of 73 to 108 m, and terminates at the source site at approximately 850 m.

Approximately three-fourths of the cable route lies offshore between Hikimoe Valley and Makahoa Point, and is therefore in an area designated Class AA Open Coastal Waters. The regulatory objective is to maintain such areas in their natural, pristine state as nearly as possible, with an absolute minimum of pollution or alteration of water quality. The project cable, involving no pollution or alteration of water quality, is compatible with this objective. Among the uses protected in Class AA waters is oceanographic research. Use of the cable to transmit power is part of the proposed oceanographic research activities.

Less stringent standards apply in the deep Oceanic Waters, which are all Class A, and in the Class A Open Coastal Waters. The Cable between Barking Sands and Hikimoe Valley, as well as the cable's northern terminus and the source are in Class A waters. In such waters, any use is allowed as long as it is compatible with protection and propagation of fish, shellfish, and wildlife, and with recreational uses. The project's provisions for protection of aquatic life are listed as mitigation measures (23 total) in this EIS.

Of the marine bottom types addressed by the water quality standards, only soft bottom community (defined as occurring at 2 to 40 m) occurs along the immediate cable route. The point of connection with the existing cable offshore from Barking Sands is at 24 m depth, in an area of sandy and coral rubble bottom. The cable, being simply laid on the surface of the seafloor, involves none of the complete or permanent alteration, oxidation reduction, or incompatibility with aquatic life proscribed by the water quality standards.

From the point of connection offshore from Barking Sands, the cable route moves into deeper water, passing along sandy surge channels which transect the outer reef. At 45 to 67 m, this reef is too deep to be included in the marine bottom types addressed by state water quality standards. Even so, the cable route avoids the coral, because it is important to run the cable over stable and relatively flat seabed, minimizing cable suspensions which could cause stress and breakage. (See Final Survey Report for Kauai Acoustic Thermometry of Ocean Climate Site, Seafloor Surveys International, 1993, at pp. 4-5, 21-30.)

Other potential effects of the sound transmissions upon the aquatic environment are discussed in Section 4. The program for mitigating potential adverse effects upon aquatic life is described in Sections 2 and 4 of this EIS. It includes a dedicated study of potential effects on marine animals and operational protocols (Appendix C), which will protect against major adverse effects. With these mitigation measures, the project is not expected to have any adverse effects in relation to State goals for protection of aquatic resources, as reflected in Chapters 342D and 344, Hawaii Revised Statutes.

5.3 RELATIONSHIP OF PROJECT TO STATE AND LOCAL PLANS AND POLICIES

This section considers the project's consistency with state and local plans and policies not otherwise considered, as required by the Hawaii EIS rules.

5.3.1 HAWAII OCEAN RESOURCES MANAGEMENT PLAN

Introduction

In 1988 the Hawaii State Legislature, through Act 235, the Ocean Resources Management Act (Chapter 228 HRS), mandated the drafting of the Hawaii Ocean Resources Management Plan. The purpose of the plan, which was completed in 1991, is to coordinate a consistent ocean policy framework for the various state and local agencies with responsibility for ocean and coastal resources. The boundaries addressed by the Plan are from the shoreline coastal zone out to the limit of the 200 nm (370 km) economic exclusion zone. The Plan is divided into ten different sectors with objectives, policies, and implementing actions given for each sector.

Although the plan does not have direct regulatory effect, it is considered here because it provides assistance in the implementation of regulatory programs which apply to the project. The proposed project relates to the relevant objectives and policies of the Hawaii Ocean Resources Management Plan as discussed below.

Ocean Research and Education

Objective: Develop a supportive State management system that encourages and promotes marine education and that fosters the growth, continued economic viability and effectiveness of ocean research and development in Hawaii.

The drafters emphasized the importance of ocean research and education, adopting policies to strengthen Hawaii's national and international competitiveness in attracting funds in these fields, to mitigate user conflicts between research and non-compatible uses so that research projects aren't jeopardized, and to foster stewardship attitudes. The drafters identified ocean research and education as major determinants of the Plan's long-term success.

The proposed project is consistent with this objective and its implementing policies -- especially Policies A and G concerning attracting ocean research programs and increasing public awareness. Results of the research would be made available to Hawaiian educational and scientific institutions, as well as to the public. Both the public review of the project prior to implementation, and the publication of results after completion would increase public awareness of Hawaii's ocean resources.

User conflicts are addressed by the Plan. The absence of user conflicts is discussed at Section in Sections 5.2.1 and 4.5. The project would not implicate other policies or implementing actions of this sector.

Ocean Recreation

Objective: Promote the development of safe ocean recreation opportunities which are socially and environmentally acceptable and compatible with other ocean and coastal resource uses and available to all residents.

The main recreational activities which could be affected by the proposed project are whale-watching and recreational diving off the north shore of Kauai. As is detailed in Section 4 of this EIS, the proposed project would not be expected to have a negative impact on the whale-watching industry or recreational diving. The possibility that whales could change course to avoid the sound field is considered uncertain. Such a change could temporarily effect whale-watching activities. See Section 4.4.2.

The proposed project would neither promote nor impede the ocean recreation policies dealing with existing recreational facilities, access to the shoreline, wilderness areas, water safety, conflicts between recreational activities, and promotion of ocean recreation industry.

The information obtained from the research program on marine mammal reactions to subsea noise has the potential to inform management on decisions needed to implement Policies E and F on maintaining resource quality.

Fisheries

Objective: Provide a foundation for developing an integrated State fisheries management system that ensures: 1) depleted and over-exploited stocks will be restored to sustainable levels; 2) fisheries resources will be harvested at their optimum sustainable yield; and 3) user conflicts will be minimized.

Fishery resources in the project area are discussed at Section 3.3.3, and potential effects on these resources are discussed beginning at Section 4.3.2.2. These potential effects are identified as minor and limited to a small zone around the sound source (at approximately 850 m depth). Habitat for stocks targeted by commercial, subsistence, and recreational fishing is at substantially less depth. The absence of user conflicts associated with this project is discussed in Sections 4.4.1 and 4.5. The issue of possible effects on the behavior of fish around the FAD located north of Hanalei is discussed in Section 5.2.2.3.

Marine Ecosystem Protection

Objective: Provide for protection of marine and coastal ecosystems, and establish a comprehensive system of marine and coastal protected areas within an integrated program which protects, preserves and enhances marine species and areas of exceptional *resource value on each main island, representing each of the natural ecosystems and resources found in the marine and coastal environment of the State.*

Policy A calls for the "protection of species, natural habitats and other resources of exceptional value." In the short term, the MMRP would result in increased information about marine mammals, and in the proposed project would provide information about global climate changes. This research data could be used by resource managers to protect valuable natural resources. Operational protocols to protect aquatic species and habitats have been incorporated in the project (Appendix C).

Policy D calls for "enhanced local community awareness, appreciation, and participation in marine conservation and preservation efforts." The results of the MMRP would be made available to local educational and scientific institutions and the public. Both the public involvement in the review of the proposed project, and public dissemination of the results of the research would increase community awareness and appreciation of marine mammals and their environment, thereby aiding conservation and preservation efforts. The Kauai CAG has been proposed as another way of enhancing community participation.

Beaches and Coastal Erosion

Objective: Develop an integrated State erosion management system that ensures: 1) the preservation of sandy beaches and public access to and along the shoreline; and 2) the protection of private and public property from flood hazards and wave damage.

Policy J of the Hawaii Ocean Resources Management Plan is to "plan for climate change, sea level rise, and emerging issues." The proposed project has the potential to provide essential information on global climate change. This information would be made available to the scientific and regulatory communities, and therefore could aid in the implementation of Policy J. See Section 5.2.1 on Coastal Hazards.

Other Sectors

The proposed project would have no impact on any of the objectives, policies, or implementing actions of the Harbors, Waste Management, Fisheries, Aquaculture, Energy, and Marine Minerals sectors.

5.3.2 COUNTY OF KAUAI

The County of Kauai has provided notice (Appendix D) that, because the proposed project would be located in ocean waters seaward of the County's Special Management Area, a special management area permit under Hawaii Revised Statutes, Chapter 205A, will not be required. The County exercises no other regulatory authority in relation to the project.

5.4 FINAL HUMPBACK WHALE RECOVERY PLAN

NMFS, under the auspices of the National Oceanic and Atmospheric Administration (NOAA), is responsible for applying the ESA to most marine mammal species, including the humpback whale. To aid in the conservation of the humpback, NOAA directed the Humpback Whale Recovery Team to prepare a Recovery Plan. The Final Humpback Whale Recovery Plan (Recovery Plan) was approved by NMFS in 1991.

The Recovery Plan sets out a series of recommended goals and actions for: 1) maintaining and enhancing the habitats of humpback whales; 2) identifying and reducing death, injury or disturbance to the whales caused by humans; 3) performing research to evaluate progress toward recovery goals; and 4) implementing the Recovery Plan through improved administration and coordination.

The MMRP and acoustic thermometry research relate to the goals of, the Recovery Plan, as discussed below. (See further discussion of this species at Sections 3.3 and 4.3) Many of these goals depend on increasing our knowledge of the whale, its habits and habitat. Goal 1.14, for example, calls for basic information on the whale's behavior. Goal 3.5 requires information about habitat use to determine management actions, and Goal 3.412 is to accumulate data on sightings. Other goals call for photographic surveys (Goal 3.522) and underwater listening stations (Goal 3.5232). All of these goals are components of the Kauai MMRP.

Additionally, the MMRP would acoustically monitor humpbacks for vocal behavior (singing, calling, social sounds) and movement patterns, both during sound transmissions, and between signals, supporting Goal 3.5232. The whales would also be visually surveyed from shore and from the air for surface behavior (blow intervals, duration at surface, etc.) and movement patterns (swim direction, speed, etc.)

Several of the goals of the Recovery Plan require more information on the current acoustic regime of the humpback habitat. Goal 1.14 calls for detailed descriptions of physical and biological characteristics of current habitats, including "acoustic characteristics." Goal 1.3111 focuses on the need to reduce noise disturbance in Hawaiian waters; although it is hesitant about recommending additional noise research because of the expense and possible ambiguous results and, therefore, emphasizes reduction of human-produced underwater noise as more direct and cost-effective than additional research.. The MMRP would involve short-term increase in underwater sound in the area. Whether this temporary increase in sound level would induce "disturbance" is uncertain, although it appears unlikely given the depth of the sound source (850 m) and the diving capability of the humpback whale (150 m). See Section 4.3.1.1. This issue would appropriately be weighed in light of what is known about the potential effects of low frequency sound on humpbacks, as well as consideration of the MMRP's value in providing information to assess accurately the potential for impacts of noise, and implement Goal 1.3111 to reduce noise disturbance in Hawaii. It would measure comparative sound levels of endemic noise-producing sources in the north Kauai area, including whale-watching vessels, recreational power boats, thrillcraft, and low-flying aircraft. In addition, it would provide controlled study data on the response of marine mammals to underwater low frequency sound.

Although the experiment would involve noise levels above typical ambient conditions during transmissions, its contribution to the overall amount of undersea noise off the north coast of Kauai would be limited because of the short duty cycle, and would occur in an area of Hawaiian waters that appears to be less populated by humpbacks than other sites, such as the waters off Maui. If the MMRP provides evidence that existing subsea noises are adversely affecting marine mammals, data from the study would help provide a foundation for noise controls which responsible agencies may seek to implement in order to reduce ambient subsea noise levels off Kauai.

The Recovery Plan also encourages public education about humpback whales and international cooperation in conserving the whale and its habitat. Goals include mutual exchange of information between nations (Goal 1.73), effective communications with groups interested in marine affairs (Goal 4.3), and increased public education (Goal 4.9). Continuing education about the project would give the public more scientific information about the oceans and their inhabitants, including humpbacks.

In summary, the marine mammal research component of this project, while temporarily adding controlled low frequency sound to the ambient acoustics, would further the goals of the Recovery Plan by providing needed scientific data on the animal, its behavior and habitats, educating the public about marine mammal issues, and promoting international cooperation on global ocean research and preservation of marine animals. The findings of the MMRP would also be used to determine any changes in acoustic thermometry operations that may be needed to provide protection of the species consistent with the Recovery Plan (Section 2.1.1, Appendix C).

5.5 POTENTIAL HAWAIIAN ISLANDS HUMPBACK WHALE NATIONAL MARINE SANCTUARY EXPANSION

This section responds to requests made during the scoping process that the EIS consider the compatibility of the MMRP and acoustic thermometry activities with potential future expansion of the Hawaiian Islands Humpback Whale National Marine Sanctuary.

The Oceans Act of 1992 established the HIHWNMS, defined to include, among other areas, the submerged lands and waters adjoining the Kilauea Point National Wildlife Refuge on the island of Kauai, out to the 100 fath (200 m) isobath. None of the proposed project facilities or activities would be within the sanctuary boundaries.

Expansion of the HIHWNMS boundaries is being considered. However, the areas proposed for expansion generally retain the limitation to nearshore areas within the 100 fath (200 m) isobath and, therefore, do not include the source location. Based on FEPE computer model acoustic analysis, the extent of the 120 dB sound field borders on the 200 m depth contour, and thus some increase in ambient noise levels <120 dB could be expected in a portion of the expanded boundary during sound transmissions.

The National Marine Sanctuary Act requires federal agencies to consult with the Secretary of Commerce or designee on any actions, internal or external to a National Marine Sanctuary (including provate activities authorized by licenses, leases, or permits), that is "likely to destroy, cause the loss of, or injure, any sanctuary resource." 16 U.S.C Sec. 1434(d) There is no expectation of any destruction, loss or injury of any sanctuary resource, within, or outside of the sanctuary, from the proposed action.

5.6 REGULATORY PROGRAMS THAT DO NOT APPLY TO THE PROPOSED PROJECT

Other than the regulatory programs discussed above, no additional permits or regulatory requirements are considered applicable to the proposed project or the MMRP. Potentially applicable programs that were considered in coming to this conclusion include the following:

- County of Kauai Special Management Area requirements under the Shoreline Protection Act; County Shoreline Setback Rules and Regulations
- Endangered Species Act review by the U.S. Fish and Wildlife Service
- Clean Water Act
- Outer Continental Shelf Lands Act
- Title I, Marine Protection, Research and Sanctuaries Act (ocean dumping)
- National Historic Preservation Act
- Noise Pollution Requirements under Chapter 342F, Hawaii Revised Statutes

6 ADDITIONAL ISSUES

This section of the EIS addresses a number of ancillary issues under NEPA and Hawaii Environmental Policy Act (HEPA) requirements, including the relationship of short-term uses and long-term productivity, irreversible and irretrievable commitments of resources, natural or depletable resource requirements and conservation potential, a summary of probable adverse impacts which cannot be avoided, unresolved issues, scientific uncertainty, growth-inducing effects and environmental justice.

6.1 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

NEPA and HEPA require consideration of the relationship of short-term uses and long-term productivity. Generally speaking, this consideration is less applicable to projects, such as the MMRP and acoustic thermometry program, which would not exploit resources over the short term at the expense of long-term environmental values.

The proposed action would not be expected to result in adverse environmental effects that would have the potential for permanently altering the physical, biological, economic, or social resources of Hawaii. Project activities would not be expected to result in environmental effects which could permanently narrow the range of beneficial uses of the environment by Kauai residents, or pose any long-term risks to the health, safety, or general welfare of the public.

The proposed project would result in local short-term increases in boat traffic and air traffic as part of the MMRP, but would be virtually negligible. Shipboard visual and acoustic surveys would also be conducted as part of the MMRP. Refer to Appendix C for further information regarding short-term aerial and shipboard survey activities.

The project would result in minor short-term changes in the local marine acoustic environment as a result of the operation of the sound source. As discussed in Sections 3 and 4 of this EIS, the operation of the sound source is not anticipated to adversely affect the maintenance and enhancement of the long-term productivity of the environment.

The MMRP research proposed would have the potential for beneficial biological, economic and social implications in the long-term. Results of the marine animal research that would be performed would help to quantify the marine animal inventory for the proposed study area. Identification and quantification of the potential effects of low frequency sound on marine animals would help Kauai (and Hawaii) determine the need for possible operational restrictions on human-made noise sources (e.g., merchant ship traffic, whale-watching boats, thrillcraft, etc.). Similarly, the proposed project could provide important information supporting government policies and regulations to curb global warming.

As stated in the discussion of project objectives (Section 1), there are important justifications for proceeding with the project at this time in order to develop the optimum method of exploiting climate prediction models for measuring global climate change. Proceeding with the project at this time would not foreclose options to implement alternative global climate change study methodologies in the future.

6.2. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

NEPA and HEPA require consideration of the irreversible and irretrievable commitments of resources as a result of proposed projects.

The proposed acoustic thermometry project and MMRP activities would not constitute any irreversible or irretrievable commitment of nonrenewable or depletable environmental resources of the area off the north shore of Kauai, other than the small amount of materials and energy expended during performance of the MMRP research efforts (e.g., plane, boat and vehicle fuel expenditure, and standard office and research product usage). The only addition of any resources into the environment would be the acoustic source on the seafloor, and proposed sound emanations into the deep ocean sound channel. However, both the placement of the source and sound emanations are completely reversible and removal of the sound source is expected upon completion of the project.

The proposed project and MMRP activities also do not present the potential for an accident affecting the quality of the environment.

Both the moored autonomous source and Johnston Atoll alternatives would result in increased vessel and other usage of fuels, resulting in somewhat greater impacts as compared to the proposed action.

6.3 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL

For the proposed alternative, MMRP aircraft and vessel operations would use relatively small amounts of fuel. In addition, power for the source would be supplied from the onshore grid. Those power requirements, when the source is operating, would be less than 2 kw input (due to power line losses and inefficiencies, the source would produce an acoustic output of approximately 260 watts). Taking into account the relatively low duty cycle of the source, the electricity requirements to power the source would be substantially less than that of an average single-family home.

Anticipated energy requirements of the acoustic thermometry program and MMRP would be well within the energy supply capacity of the Kauai fuel supply and power grid. No new power generation capacity or energy supply facilities would be required for any of the MMRP research team efforts, or for the acoustic source signal generation.

Other than the various structural materials used for fabrication of the acoustic source system, and fuels, no natural or depletable resources would be required.

6.4 SUMMARY OF PROBABLE ADVERSE IMPACTS WHICH CANNOT BE AVOIDED; UNRESOLVED ISSUES

As set forth in Section 4, the proposed project and MMRP are not anticipated to result in reasonably foreseeable adverse effects on biological resources. This conclusion is based in part upon the available information regarding the marine animal species that could potentially be affected, which is analyzed extensively in Section 4. It is further known that the animals that may be exposed to the project source sounds are currently exposed to noise sources of comparable or greater intensity, particularly from commercial shipping and recreational boating; the lack of literature or other reports documenting harm from these commonplace exposures is further evidence that the effects of such subsea noise are not reasonably anticipated to be consequential. The importance of potential impacts on biological resources is also limited by the temporary nature of the initial experimental activities, which will span at most a two-year period of transmissions, and the limited duty cycle of the source (on only 2% of the time, off the remaining 98%, for most of the experimental period).

There are no other material adverse impacts of the proposed project.

The principal unresolved issue presented by the proposed project is the degree to which subsea sounds in the low frequency range could potentially affect marine animals. This EIS acknowledges that the current level of knowledge on this issue is sparse. Unrecognizable impacts to marine animals could have corresponding impacts on biological resources. See discussions in Section 4 above. Section 4 also summarizes the scientific evidence relevant to this issue and evaluation of potential impacts based upon reasonable extrapolations from that data. Due to this gap in knowledge, the MMRP is designed to investigate and analyze the potential for impacts to biological resources.

In determining whether to proceed with the ATOC project and MMRP, one of the costs that must be weighed is the cost of uncertainty -- the costs of proceeding without more and better information. By setting out this information and acknowledging the uncertainty of information in this EIS, the decisionmakers will be able to weigh the costs of proceeding despite that uncertainty, and determine whether the benefits of proceeding without further delay outweigh those costs, or whether the project should be delayed until further information is obtained. Since the project itself is intended to fill information gaps and reduce uncertainty concerning the global warming question, as well as the question of the possible effects of low frequency sounds on marine animals, both alternatives present risks and benefits that need to be weighed in that evaluation.

This EIS concludes that the benefits of this additional information, from an environmental standpoint, should justify proceeding with these activities. The benefits of the proposed project could not be fully realized by any of the other alternatives proposed.

6.5 GROWTH-INDUCING IMPACTS OF THE PROPOSED ACTION

Because the proposed project is a scientific research project, as opposed to a land development project (e.g., infrastructure, commercial or residential development), the project would not result in any appreciable growth-inducing effects. The proposed project could foster some economic activity as a result of the use of ships/boats and aircraft for survey purposes. However, this activity would not likely be of such magnitude that it would stimulate the establishment of new businesses, population growth, or the construction of additional housing. In addition, there are no project characteristics which are likely to remove obstacles to population growth or encourage or facilitate other activities that could affect the environment, either individually or cumulatively. Most of this activity would utilize existing economic resources (labor, business, etc.) in Kauai.

6.6 ENVIRONMENTAL JUSTICE

On February 11, 1994, the President signed an Executive Order on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The proposed project would cause no adverse environmental effects on any minority communities and/or low-income communities. Furthermore, the public, including minority communities and low-income communities, have full and open access to this EIS and all public information that was compiled and incorporated to develop it. This section particularly addresses the native Hawaiian population, as well as low-income persons, on the north shore of Kauai who practice subsistence fishing in the waters surrounding Kauai. It is noted that the total catch by Kauai fishermen in the area off the north shore of Kauai was approximately 17,000 kg (37,500 lbs) in 1993. It is also noted that the Division of Aquatic Resources placed a fish aggregating device (FAD) approximately 16 km away from the proposed source site. Sections 3.3.3, 4.3.2.2, 5.2.1, and 5.2.2.3 address the fish species expected in the study area, the potential for acoustic impact on those species, and the potential for interference between the proposed source and the FAD, respectively.

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APPENDIX A

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APPENDIX B

List of Acronyms and Abbreviations
and
Glossary of Terms

List of Acronyms & Abbreviations

AATSR	Advanced Along Track Scanning Radiometer
ADL	Acoustic Data Logger
AIC	Ailkaike's Information Criterion
ALACE/PALACE	(Profiling) Autonomous Lagrangian Circulation Explorer
AN	Ambient Noise.
ARPA	Advanced Research Projects Agency
ATOC	Acoustic Thermometry of Ocean Climate
ATOC(AET)	Acoustic Thermometry of Ocean Climate (Acoustic Engineering Test)
ATSR	Along Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AVLA	Autonomous Vertical Line Array
BT	Bathythermograph
CAG	Community Advisory Group (Kauai)
CDUP	Conservation District Use Permit
CEQA	California Environmental Quality Act
CEROS	Center for Excellence for Research in Ocean Science
COE	(U.S. Army Corps) of Engineers
CPA	Closest Point of Approach
CPY	Current Potential Yield
CTD	Conductivity-Temperature-Depth
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
DAS	Data Acquisition System
DAT	Digital Audio Tape
dB	Decibel
DEIS	Draft Environmental Impact Statement
DLNR	Department of Land and Natural Resources
DMAH/TC	Defense Mapping Agency Hydrographic/Topographic Center
DO	Dissolved Oxygen
DoD	Department of Defense
DOH	Department of Health
DOT	Department of Transportation
DSL	Deep Scattering Layer
EEZ	Economic Exclusion Zone
EIR	Environmental Impact Report (Calif.)

EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERM	Exact Repeat Mission
ERS	Earth Resources Satellite
ESA	Endangered Species Act
ETP	Eastern Tropical Pacific
FAD	Fish Aggregating Device
FEPE	Finite Element Parabolic Equation
FLIP	Floating Instrument Platform
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FWS	Fish and Wildlife Service
GAMOT	Global Acoustic Mapping of Ocean Temperatures Program
GCM	Global Climate Model
Geosat-ERM	Geosat-Exact Repeat Mission
GPS	Global Positioning System
HAS	Hawaii Audubon Society
HDBED	Hawaii Dept. of Business & Economic Development
HEPA	Hawaii Environmental Policy Act
HF	High Frequency (10-1000 kHz)
HIFT	Heard Island Feasibility Test
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
HiTS	Historic Temporal Shipping (Density Model)
HLA	Horizontal Line Array
HOMRC	Hawaiian Ocean and Marine Resources Council
HORMP	Hawaii Ocean Resources Management Plan
HRPT	High Resolution Picture Transmission
HRS	Hawaii Revised Statutes
HSWRI	Hubbs Sea World Research Institute
HURL	Hawaii Undersea Research Laboratory
Hz	Hertz (cycles per second)
IAP	(Russian) Institute of Applied Physics
IUSS	Integrated Undersea Surveillance System
JACADS	Johnston Atoll Chemical Agent Disposal System
KCC	Kauai Community College
km	kilometer(s).
Leq	Level equivalent (source level)
LF	Low Frequency (100-1000 Hz)

LFS	Low Frequency Sound
LTPY	Long-term Potential Yield
m	meter(s)
MF	Medium Frequency (1-10 kHz)
MIT	Massachusetts Institute of Technology
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMRP	Marine Mammal Research Program
MMRPAB	Marine Mammal Research Program Advisory Board
MMS	Minerals Management Service
MODIS	Moderate-Resolution Imaging Spectroradiometer
MRT	MMRP Research Team
NASA	National Aeronautics and Space Administration
NAUI	National Association of Underwater Instructors
NAVOCEANO	Naval Oceanographic Office
NEPA	National Environmental Policy Act
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOTAM	Notice to Mariners
NPTZ	North Pacific Transition Zone
NRL	Naval Research Laboratory
OCEA	Office of Conservation and Environmental Affairs
OCRM	Office of Coastal Resource Management
OEQC	(Hawaii) Office of Environmental Quality Control
OLS	Operational Line Scanner
OMZ	Oxygen Minimum Zone
ONR	Office of Naval Research
OSHA	Occupational Safety and Health Administration
OSP	(Hawaii) Office of State Planning
OTEC	Ocean Thermal Energy conversion
OTIS	Ocean Thermal Interpolation System
OTTED	Office of Technology Transfer and Economic Development (Hawaii)
PADI	Professional Association of Divers International

PALACE	Profiling Autonomous Lagrangian Circulation Explorer
PE	Parabolic Equation
POA&M	Plan of Action and Milestones
POBSP	Pacific Oceanic and Biological Survey Program
ppt	parts per thousand
PRSG	Pacific Regional Scientific Review Group
PTS	Permanent Threshold Shift
RAY	Recent Average yield
RL	Received Level
ROV	Remotely Operated Vehicle
SCORP	State Comprehensive Outdoor Recreation Plan
SERDP	Strategic Environmental Research & Development Program
SIO	Scripps Institution of Oceanography
SL	Source Level
SLTDR	Satellite-Linked Time/Depth Recorder (animal tag)
SMA	Shoreline Management Agency
SMMR	Scanning Multi-channel Microwave Radiometer
SNR	Signal to Noise Ratio
SOFAR	Sound Frequency and Ranging
SOSUS	Sound Surveillance System
SPL	Sound Pressure Level
SRD	Sanctuaries and Reserves Division (NOAA)
SRP	Scientific Research Permit
SSH	Sea Surface Height
SSI	Seafloor Surveys International
SSP	Sound Speed Profile
SST	Sea Surface Temperature
SWFSC	Southwest Fisheries Science Center
TDR	Time/Depth Recorder (animal tag)
TOPEX	(Ocean) Topography Experiment
TTS	Temporary Threshold Shift
UCSD	University of California, San Diego
UHF	Ultra High Frequency(>1000 kHz)
VHF	Very High Frequency (>100 kHz)
VIRR	Visible and Infrared Radiometer
VISSR	Visible Infrared Spin-Scan Radiometer
VLA	Vertical Line Array

VRT	VHF Radio Tag
WHOI	Woods Hole Oceanographic Institute
WMO	World Meteorological Organization
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity-Temperature-Depth
ZOI	Zone of Influence

Glossary of Terms

acoustic energy — The energy of an acoustic wave, measured in joules or watt-seconds.

acoustic power — The energy per unit time, measured in watts. Acoustic power is proportional to acoustic pressure squared.

acoustic pressure — Pressure variations around an ambient static pressure (such as the hydrostatic pressure in water at some depth) at acoustic frequencies.

ambient noise level (AN) — The composite noise from all sources in a given environment excluding noise inherent in the measuring equipment and platform.

auditory sensitivity — An animal's hearing sensitivity as a function of frequency.

auditory threshold — The minimum amplitude of sound that can be perceived by an animal in the absence of significant background noise.

bandpass filter — A filter with high- and lowpass cutoff frequencies to pass only a band of frequencies.

beneficial impact — Impact conducive to the promotion of well-being.

critical band — The frequency band within which background noise can effect detection of a sound signal at a particular frequency.

cylindrical spreading — Sound spreading for cylindrical waves. The transmission loss for cylindrical spreading is given by 10 $\log_{10}(\text{Range}/R_o)$, where R_o is some reference range. The received level diminishes by 3 dB when range doubles, and by 10 dB for a tenfold increase in range.

cylindrical wave — A sound wave whose fronts are cylindrically shaped. For a point source in shallow water, a cylindrical wave forms at distances large compared to the water depth because of the way reflected sound from the surface and bottom reinforces the direct wave.

decibel (dB) — A logarithmically based relative pressure of sound strength. A sound pressure P can be expressed in dB as a sound pressure level of $20 \log_{10}(P/P_{ref})$, where P_{ref} is a reference pressure (usually a standard pressure like 1 μPa). Note that $20 \log(X)$ is the same as $10 \log(X^2)$, where X^2 is the mean square sound pressure and is proportional to power, intensity or energy.

delay	The time in seconds by which one waveform lags behind another. For example, reflected sound will usually be delayed in reaching a receiver compared to directly traveling sound.
Doppler shift	The change in the frequency of a received signal caused by motion of the source, the receiver, or both.
duty cycle	The percentage of time a given event or activity occurs. The term is usually applied to a periodic activity; i.e., an activity in which the on-off cycle repeats with the same duration of each cycle.
fathom	The common unit of depth in the ocean, equal to six feet (or 1.83 m).
frequency	The rate at which a repetitive event occurs, measured in Hertz (cycles per second).
Hertz	Cycles per second.
hydrophone	A transducer for detecting underwater sound pressures; an underwater microphone.
infrasonic	A term used to refer to sound energy at frequencies too low to be audible to humans - generally, frequencies below 20 Hz.
masking	The obscuring of sounds of interest by stronger interfering sounds.
minimal impact	Constituting the least possible degree of impact.
octave band	A frequency band whose upper limit in Hertz is twice the lower limit.
peak level	The sound level (in dB) associated with the maximum amplitude of a sound.
point source	A point from which sound is radiated, useful in describing source levels by a pressure level at unit distance.
propagation loss	The loss of sound power with increasing distance from the source. Identical to transmission loss. It is usually expressed in dB referenced to a unit distance, like 1 m. Propagation loss includes spreading, absorption and scattering losses.

reflection	The physical process by which a traveling wave is returned from a boundary. The angle of reflection equals the angle of incidence.
refraction	The physical process by which a sound wave passing through a boundary between two media is bent. Refraction may also occur when the physical properties of a single medium change along the propagation path.
scattering	The irregular reflection, refraction or diffraction of sound in many directions.
shadow zone	The region in which refraction effects cause exclusion of sound.
sound channel	A horizontal layer which is bounded by levels at which the velocity of propagation is greater than at any depth within the layer.
sound pressure level (SPL)	The measure in decibels of sound pressure. The common unit is dB re 1 μPa.
source level (SL)	A description of the strength of an acoustic source in terms of the acoustic pressure expected a hypothetical reference distance away from the source, typically 1 m. SL is given in unites of dB re 1 μPa-m.
spherical spreading	Sound spreading for spherical waves. The transmission loss for spherical spreading is given by 20 $\log_{10}(\text{Range}/R_O)$, where R_O is some reference range. The received level diminishes by 6 dB when range doubles, and by 20 dB for a tenfold increase in range.
spreading loss	The loss of acoustic pressure with increasing distance from the source due to the spreading waveforms.
threshold of detectability	The level at which a sound is just detectable.
traffic noise	That portion of ambient noise which is caused by shipping.
transducer	A device for changing energy in one form (i.e., mechanical) into energy in another form (i.e., electrical).
transmission loss (TL)	The loss of sound power with increasing distance from the source. Identical to propagation loss. It is expressed in dB referenced to a unit distance, like 1 m.
ultrasonic	Sound energy at frequencies too high to be audible to humans - generally, frequencies above 20,000 Hz.

waveform The functional form, or shape, of a signal or noise vs. time.

wavelength The length of a single cycle of a periodic waveform. The wavelength l, frequency f and speed of sound c are related by the expression c = f l.

APPENDIX C

Kauai MMRP Pilot Study Research Protocol

KAUAI MMRP PILOT STUDY RESEARCH PROTOCOL
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KAUAI MMRP PILOT STUDY RESEARCH PROTOCOL

I. EXPERIMENTAL OVERVIEW

An MMRP Pilot Study during which any and all use of the Kauai acoustic thermometry project source is controlled by MMRP scientists will be conducted. This is to allow marine mammal biologists the opportunity to conduct a series of acoustic experiments (i.e., source transmissions), using the project source as the acoustic signal type. The duration of this pilot study will encompass the field season for humpback whales in the Hawaiian Islands, but will commence shortly after issuance of a Scientific Research Permit (SRP). This protocol has been designed to obtain data that will provide critical evidence concerning the potential effects of low frequency acoustic transmissions on marine animal behavior and distribution. Baseline behavioral data for humpbacks, as well as aerial survey data on marine mammals, collected during 1993, 1994 (see Appendix G), and 1995 seasons, will be compared with results from the proposed acoustic experiments. 1995-96 data will be collected by 6 means: two primary observation platforms (shore-based visual observations and aerial behavioral observations); and three secondary support platforms (vessel-based visual and acoustic monitoring, a source-mounted vertical line array [VLA], and aerial surveys). In addition, playback studies on humpback whales will occur off the Kona coast of the Big Island. Utilization of an experimental protocol with controls and replication will increase the ability to detect potential acute or short-term effects (Table C-1) of low frequency sound transmissions on marine animals. The MMRP Director will report all research results to NMFS. These results will also be reviewed by ARPA, Scripps, the Marine Mammal Commission (MMC), the MMRP Advisory Board, a designated public Kauai Community Advisory Group (CAG), and other interested scientists.

A 6-10 month study period is proposed, beginning approximately in the Aug/Sep 1995 timeframe, and continuing through March/April 1996. If the start is delayed, the Pilot Study would be contracted to a minimum of approximately 6 months. This timing is chosen to maximize opportunities with the focal species (humpback whales) and other less abundant species in the area off the north shore of Kauai. The source will always be operated with the standard transmission waveform and profile of 5 min ramp-up and 20 min signal duration. This profile will be maintained for all transmissions to remove signal duration as a variable in analyses. The following parameters will be experimentally varied by the MMRP Research Team (MRT):

- Start time
- Source power level (0=off (control), 185 dB=Medium, 195 dB=High; re 1 μPa at 1 m)
- Repetition rate, x ($2 \leq x \leq 48$ hr interval between transmissions)

During the post-Pilot Study phase, a MMRP research effort would continue, probably including all or most of the described methodologies, but perhaps involving reallocation of effort among techniques to optimize the assessment capabilities (given what would by then have been learned during the Pilot Study).

A. Opportunistic Experiment Methodology

The marine mammal research team (MRT) Leader (Dr. C. W. Clark/Dr. A. Frankel, of Cornell University Bioacoustics Research Program) will have either continuous radio or direct contact with each of the field teams to determine which of them have obtained adequate pre-exposure observation data on focal animals. Observers will know that a transmission period is underway, but will not know if it is at 0 (control), 185, or 195 dB level, since the transmission type will be randomized. Based on previous humpback whale observation efforts (Smultea et al., 1994) at least 25 min of pre-exposure observation data are considered necessary for comparing differences between behaviors prior to, during, and after an acoustic experiment. On any given day, the objective will be to time an experimental transmission period to coincide with at least one of the two primary observation platforms that has obtained sufficient pre-exposure data (shore-based visual platform or aerial behavioral observation platform), such that roughly equal numbers of transmissions are associated with each of the two platforms. This process of choosing the platform to which the transmission is timed will be achieved by randomizing the order of priority for the platforms -- i.e., there will be a sequence of randomized lists, where each list has the two types of observation platforms. The MRT Leader will attempt to time the experiment with the primary observation platform on the list. If this proves to be impossible (e.g., due to poor weather conditions or lack of focal animals), the MRT Leader will attempt to time the experiment with the other primary observation platform. Night-time experiments will be conducted in conjunction with the source-mounted VLA because it is the only one that can operate under darkness. By this operating procedure, the MRT Leader will determine when the source transmits, based on his knowledge of what is happening at each of the research platforms, where the decision will be based on observation conditions (weather, sea state, etc.) and context (focal group type, distance from source site, etc.). All observation personnel will remain "blind" to the experimental context (off vs. transmission) and the type (source level: 0 [control], 185, 195 dB for June-October/November data collection when humpbacks are not present; then 0 [control] and 185 dB for approximately the first 4 weeks of the humpback season [November/ December]). If no acute or short-term responses (Table C-1) are observed during this period, the source level options thereafter would be 0 (control), 185, and 195 dB. The goal would be to obtain roughly equal sample sizes of data during the four week (approximate) phase (0 [control] vs. 185 dB); and also thereafter (0 [control] vs. 185 dB vs. 195 dB).

The start time for an experiment can be determined two ways; the first is strictly opportunistic, and the second is from a Randomized Transmission Table (RTT) of potential transmission times for each day, covering the entire season (see paragraph I.B. below). An opportunistic time for transmission is selected if: a) at least one of the primary observation platforms has obtained adequate pre-exposure data, and b) transmission times on the RTT for that date do not coincide with the field situation in such a way that would result in a loss of transmission opportunity. In this case, the MRT Leader can initiate an experiment with a start time that is not part of the RTT schedule. Otherwise, the appropriate time from the RTT is selected. To initiate a transmission, the MRT Leader will contact, via modem, the computer that contains the RTT schedule and all experimental data types. This computer resides at Barking Sands, and controls the actual signals transmitted by underwater cable to the source site. The

MRT Leader will then key in the appropriate codes to activate a transmission at the selected time and with the appropriate source level.

The MRT Leader will retain the authority to use his discretion in timing transmissions (within the 2-48 hr window) to increase opportunities to collect data on animals close to the source site and/or on species that are rarely observed but for which experimental observations are considered important (e.g., sperm whales). Scan samples are typically carried out prior to, and subsequent to, each focal group observation; i.e., they are not scheduled. The MRT Leader will have knowledge of the level of scan-sampling and focal observations for each team, to ensure that over the course of the Pilot Study, adequate data collection occurs during:

- 25 min prior to start of the 5 min ramp-up
- 5 min ramp-up
- 20 min transmission
- 25+ min after the 20 min transmission

The aim of this experimental approach is to provide adequate sample sizes so that the data can be used to test for the significance of differences in a suite of behavioral parameters collected under control and experimental conditions. Each observation platform provides a different type of coverage; differences primarily relate to area and time of day. Thus, shore-based visual observation covers the nearshore area out to a range of approximately 5-8 km, depending on station altitude, sea state and visibility conditions, and aerial observation methods collect detailed focal group data from animals that could inhabit the entire north shore area. By utilizing and coordinating the data from the different platforms under control and experimental conditions, behavioral information will be available that will allow the team of trained marine mammal biologists to evaluate the potential effects of the source on marine animals. This same team will be responsible for detecting and evaluating whether any acute or short-term effects (Table C-1) are associated with the source transmissions.

In the case of canceling an opportunistic experiment transmission, the MRT Leader will contact Barking Sands and cancel the transmission.

B. Randomized Experiment Methodology

The MRT Leader will develop by month a RTT, which will include a look-up table of dates, times and source levels to be transmitted. Each experimental transmission will be given a numeric designation (year-month-transmission #; e.g., 95-10-06 = 6th transmission for October 1995). All three experimental parameters will be randomized, within the framework of established guidelines stated above. Barking Sands will receive the month's RTT at least two weeks early, which will allow enough time for discussions and comments with the MRT Leader, if required.

These randomized transmissions are meant to be superimposed on the opportunistic experiments, but will be conducted only if initiated by the MRT Leader. In most cases the opportunistic experiments will take precedence over the randomized transmissions. The final determination will be the responsibility of the MRT Leader, in consultation with the field teams. This will require an open-line communication link between Barking Sands and the Princeville MRT house, via both modem and voice (telephone).

The significance of the RTT schedule is the juxtaposition of an unknown transmission schedule during routine observations. This makes all the data collectors "blind" to the experimental condition and, therefore, as unbiased as possible. In the case of opportunistic transmissions, the signal type (185 dB, 195 dB and no sound) is randomized so that the observers remain unbiased, even though they know that a transmission period is underway. In the case of the RTT, the randomization applies to the periods of time (as well as the signal type) when the transmission might occur. This also allows some baseline network receivers to be programmed to collect long-range acoustic data on a not-to-interfere basis with the MMRP Pilot Study.

In the case of canceling a randomized transmission, the MRT Leader (the only person on site who has knowledge of the RTT schedule) will call Barking Sands and cancel the transmission.

C. Research Methodology Matrix

Table C-1 is the Kauai MMRP Research Methodology Matrix. It indicates which potential marine animal response data can be collected by the different research data collection methods. It also indicates whether the method provides a primary capability, a potential/limited capability, or no capability.

1. Source Shut-Down Guidelines

If at any time an MMRP Research Team (MRT) member positively identifies the occurrence of an acute or short-term effect (Table C-1), the information would be immediately communicated to the MRT Leader (Dr. C. Clark/Dr. A. Frankel, both of Cornell University Bioacoustics Research Program). If the MRT Leader ascertains that an acoustic transmission (i.e., during the 5-min ramp-up or the 20-min transmission) coincided with the observed response, he/she would contact the Barking Sands shore termination site and Scripps, and suspend source operations immediately until further notice. The MRT Leader would collate all pertinent information relative to the incident and [if Dr. Frankel was the acting MRT Leader] contact the MMRP Director (Dr. C. W. Clark, Cornell University) and NMFS (Office of Protected Resources; A. Terbush or J. Drevenak) to inform them of the situation. NMFS, in consultation with the MMRP Director, would make the determination as to the severity of the situation, based upon the knowledge of the species type, the animal's location relative to the source, the source level at the time of the incident, the estimated received level at the animal, whether there were any other noise sources in the vicinity, etc. Based upon analysis of the information supplied, NMFS would direct that one of the following options be executed:

POTENTIAL RESPONSE / RESEARCH DATA COLLECTION METHODS	Vessel-Based Visual Monitor.	Vessel-Based Acoustic Monitor.	Source-Mounted VLA (Pass. Acoust)	Shore-Based Visual Surveys	Aerial Behav-ioral Obs.	Aerial Acoustic Msmts. (sono-buoy)	Aerial Surveys (visual)	Cetacean Playback Studies
1. Change in Swim Pattern/direction	o		o	•	•			•
2. Change in Ventilation Rate	o	o	o	o	•			•
3. Change in Vocalization Pattern/Rate		•	•			o		•
4. Change in Surface Activity								
a. Feeding/Socializing/Nursing[1]		o	o	•	o			
b. Aerial Behavior	o			•	o			•
5. Change in Diving Behavior								
a. Dive Depth								o
b. Dive Duration	o	o		o	o			•
6. a. Acute Response[2]								
• Animal dead or disabled	o			o	•		•	
• Increase in number of beached animals				o			o	
• Increase in number of animals struck by vessels	o			o	o		o	
b. Short-Term Response[2]								
• Potential injurious behavior (outside known baseline activities)								
- Repeated/prolonged activity (vocalizations, blowing, time on surface, etc.)	o	•	•	•	•	o	o	
- Abnormal number of animals present/absent	o	o	o	•	•	o	•	
- Abnormal mother-calf activity	o			•	•		o	
7. Long-Term Changes								
a. Habituation	o	o	•	•	o	o	•	
b. Displacement	o	o	o	•	o	o	•	
c. Cessation/disruption of significant biological activity (i.e., viability or reproductive potential)[2]								
- Animals obviously and consistently avoid area (or are attracted to it) when "on" and do not return (or depart) when it is "off."	o	o	o	o	o	o	•	•
PHYSICAL AUDITORY EFFECTS								
1. Hearing threshold/TTS level								o

[1]There is minimal evidence of humpback whales feeding in Hawaiian waters (Dawbin, 1966; Tomilin, 1967; Salden, 1989)
[2]Source shut-down guidelines if observed in relation to source transmission.
Determination Capability: • Primary Capability o Potential/Limited Capability Blank = No Capability

Table C-1. Kauai MMRP research methodology matrix.

- Continue experiment as planned;
- Continue experiment with modifications to maximum source level or repetition rate; or
- Suspend experiment pending consultation with Scripps and NMFS.

Regardless of the decision, within 24 hr a written summary of the incident would be forwarded to ARPA, Scripps, NMFS, the MMC, the MMRP Advisory Board Chairman, and the Kauai CAG.

II. PROPOSED MEASUREMENTS

A. Vessel-Based Visual and Acoustic Monitoring

During the Pilot Study when no humpback whales are present, vessel-based visual and acoustic monitoring will be performed on an opportunistic basis from the 5.5 m MALOLO (built in 1986, powered by two 70 hp Mercury outboard motors).

1. CTD/XBT Casts.

Attempts will be made to outfit the vessel with both Conductivity-Temperature-Depth (CTD) and Expendable Bathymetric-Temperature (XBT) capability. The CTD system would be a SeaBird Model 19 with 256K RAM and the cability of downloading directly to a PC. The data can be manipulated, plotted and stored using SeaBird software. CTDs and XBTs will be used during relatively calm weather (≤SS3). XBTs can be used at any time, as the vessel does not need to be stopped, whereas the vessel must be drifting to deploy the CTD system.

These data will be included in the daily encoded computer input data set, to be downloaded to the main computer system at the Princeville MRT house daily. CTD/XBT data points will be input into the PE model for acoustic performance prediction analysis when new data warrants (e.g., after storms).

2. Passive Acoustic Monitoring with a VLA.

Physical acoustic recordings will be collected with a 81 m calibrated VLA of approximately 4 hydrophones. The array will be deployed from the MALOLO, which will have a GPS unit onboard. The U.S. Coast Guard is supposed to begin broadcasts of differential correction information by 1996; failing this, post-processing will have to be used to gain positional accuracy. Recordings of ambient noise--including other noise sources, marine animal vocalizations, and ATOC source received levels--will be made on a multi-channel DAT recorder. Recording samples for ambient noise and RLs will be taken from a set of approximately 20 fixed stations, located at specific ranges and bearings from the source site, with at least three samples taken from each of the stations during the course of the Pilot Study. Ambient noise measurements will be oriented, whenever possible, toward measuring the radiated noise from non-project vessels in the area. Such measurements are necessary for making an assessment of possible behavioral response due to vessel noise, and will be an important component of all the other acoustic studies being conducted. Historically, off the north shore of Kauai, most vessel traffic is local small boats, which go not normally operate in sea states > 5. More vessels operate during low sea states (≤ 3); this vessel operation bias will reduce the dynamic range of ambient noise levels somewhat. Any cetacean vocalizations (including sperm whales) picked up at this time will also be included in the data sets. The frequency limit of the multi-channel DAT recorder is dependent upon the number of channels used; dividing the available bandwidth into 4 channels gives a 10 kHz upper limit, 8 channels -- 5 kHz. A second DAT recorder will also be used, to record only 2 channels, up to 17 kHz (for small cetacean vocalizations). Time is encoded onto the DAT tape directly, which will be used to tie in the time-encoded GPS data. The unit planned to be used can store approximately 9000 fixes, with time stamps.

The primary opportunity for marine animal acoustic data collection will occur when the team members have visual contact and are able to deploy the array opportunistically. Because the array hydrophones are omnidirectional, under optimal conditions (i.e., ≥ 10 dB signal-to-noise ratio [SNR]) it could effectively detect humpbacks out to 10-12 km radius, and small cetaceans out to about 3 km radius, around the sample station. The VLA will be moved from place to place, with all measurements made while the boat motors are off and it is as stationary as possible to minimize flow noise. The VLA may be retrieved (by hand) during the course of the day while the boat is offshore, but probably not too often. There is no possibility of using the VLA to monitor at night. The data that will be collected includes:

- Identification of vocalizations of cetaceans (this facilitates the identification of humpback whales present, but in order for other cetaceans to be detectable, they would have to be vocalizing above the "humpback noise floor," meaning they would likely have to be close enough to be in visual range in order to be recorded)

- Signal patterns and rates of vocalizations.

These data will be used to determine the acoustic activities of cetaceans relative to the distance from the source site, and compare the experimental vs. control periods. The ambient data sets will allow mapping of the ambient noise levels in the area, to be collated with visual data sets of other noise sources. The RL data will allow mapping of the surface acoustic field of the projected signal.

3. Visual Monitoring

Visual monitoring from the MALOLO will be conducted on a continuous, but opportunistic, basis during offshore periods. No specific transect lines would be run; however, whenever possible the following data would be collected: bearing and distance to animal(s), species, number per sighting, direction of travel, behavior (e.g., slow swimming, fast swimming, surface resting), location, and environmental data (sea state, cloud cover, sea surface temperature, and water depth). These data will be used to help determine species composition and density, and activities of the marine animals in the area. Data regarding species composition, density, and behaviors of marine animals sighted before source transmissions would be compared with data collected during and after transmission periods.

B. Passive Acoustic Monitoring with Source-Mounted VLA

1. Detection of Vocalizing Mysticetes

The ATOC source vertical line array (VLA) is 100 m long, made up of four REFTEK 100H78A hydrophones, spaced at 33 m, with the following acoustic specifications: 1) sensitivity (Rs) -196 dbV re 1 V; 2) attenuation (Total) 1.5 dB; 3) noise bandwidth (NBW) 0-200 Hz; 4) amplitude bandwidth (ABW) 0-1000 Hz; 5) amplifier gain (G) 74 dB; 6) noise crest factor (NCF) 3 dB; maximum SNR approximately 22.5 dB. The array is buoyed up from the source by a syntactic foam float. Thus, each of the four hydrophones has a calibrated frequency response within the 10-1000 Hz band, and acoustic data from the array would be available 24 hrs a day (less the 25 min [5 min ramp-up + 20 min transmission] transmission periods). This array has no array gain and whale detections will be impacted by any nearby shipping. If one can measure received level at the animal directly, using transmission loss models, one can estimate the likely band of ranges in which the whale is located. This will be more complicated because azimuthal dependence must be accounted for.

Under optimum acoustic conditions (i.e., ≥ 10 dB SNR), the VLA should allow for detection of vocalizing whales out to approximately 20-40 km. Continuous acoustic recordings of all four channels would be provided by the Applied Physics Laboratory (University of Washington, Seattle), which is responsible for the collection of data from the array. Bioacoustic analysis of these data would be accomplished using an advanced version of the Cornell Canary system (Frankel, 1994). This system is equipped with selectable sampling rates from 100 to 12,000 Hz, and real-time spectographic display of up to eight channels. Using this system, bioacoustic activity would be monitored, identifying sounds by species, and characterizing these signals by their vocal features and rates of occurrence. Comparisons of features and rates (both prior to and after transmissions) would be accomplished using parametric and non-parametric statistics, following known bioacoustic analyses procedures used and developed at Cornell's Bioacoustics Research Program facility.

The acoustic sampling protocol would coincide with aerial surveys for comparison. Marine mammal distribution and behavior would be examined in relation to measured or estimated sound exposure (ATOC and other noise sources). Sound levels at animal locations would be estimated based on received sound levels at the array, whale and source locations, and a validated acoustic propagation loss model (e.g., FEPE). Ambient sound field data (including shipping noise) would also be collected during the Pilot Study, and follow-on MMRP research period. An important component of understanding the potential responses of animals to the ATOC sound source is an understanding of the existing natural and human-made low frequency noises the animals are subjected to on a regular basis (e.g., storms, ships, fishing vessels). Such data are essential for the informed management of marine resources, independent of the MMRP research program. The MMRP Research Team would attempt to differentiate the potential effects of the ATOC transmissions from shipping noise through signal recognition techniques and time/space correlation of ship tracks (from aerial surveys) with VLA-received noise levels.

The application of source VLA hydrophones has the potential of providing long-term monitoring of the vocal behavior of nearby mysticetes in the vicinity of the Kauai source. It also provides a mechanism for detecting associations between the operation of the source and potential changes in vocal behaviors (e.g., if whales change calling rates after source transmissions).

Recordings collected during all duty cycles (0 [control], 2%, 8%) would be analysed and compared to determine if changes in acoustic behavior occur and, if they do, how long those changes last. Of particular interest are any discernible changes in vocal rates at the termination of source transmissions. A number of research techniques would be pursued to optimize the monitoring of animals in the north Kauai area using the VLA: 1) ship and/or total ambient noise level, as measured by the VLA, can be used as a covariate to explain a substantial part of the variation in numbers of calls detected; 2) this should make it easier to find ATOC or other effects on the residual variation in call counts; and 3) supplemental data on received levels, as well as numbers of calls will be factored into the analysis.

Aerial survey and observation schedules would be coordinated to take advantage of opportunities to match visual sightings and VLA acoustic detections. Any visual/acoustic matches would be valuable for calibrating and ground-truthing the array detections.

2. Leq Analysis.

The Leq method is a proven technique for measuring long-term effects of noise on hearing damage in humans (Hirschorn, 1982). It may be beneficial in evaluating the significance of the acoustic thermometry source sound vs. other noise sources in the study area. This approach is based on acoustic power sums over long periods, and is commonly applied to human occupational noise exposure situations. OSHA uses this procedure to determine levels of sound exposure on humans in noisy workplaces (Kryter, 1985), and is based on the observed fact that hearing loss is generally a result of long-term exposure to loud sounds within the human hearing spectrum. This approach takes into account fluctuations in level and differences in the duty cycle or frequency of occurrence of various sources of noise in the area.

Two factors must be addressed in order to pursue this approach:

- Establishing a hearing spectrum for species of concern.
- Developing a metric for loudness exposure.

The first factor is met through audiogram data, some of which is available for marine animals that occur in the north Kauai area, some of which must be extrapolated. In some cases (e.g., Risso's dolphin, false killer whale, bottlenose dolphin), the MMRP is supporting research to acquire audiometric measurements which, although not for Kauai species, may be relatable to local odontocete behavioral characteristics. The second factor is accomplished as follows:

- Identify a specific location of interest (for OSHA measurements in the workplace, it is a laborer's workstation; for Kauai, it will be the received level at an animal, or animals; otherwise, the 120 dB sound field will be used).

- Continuously record the ambient noise at the location of interest (for OSHA it is for a normal 8 hr workday; for Kauai, it will be 24 hr/day).

- Integrate the data over 1 hr intervals to get results that equal a sound level that, if played continuously throughout the day, would have resulted in the same total energy (power integrated over time) as that which actually occurred--i.e., Leq. The processing technique uses an equal loudness weighting for sounds at different frequencies, a threshold-like result. Thus, sounds that are poorly heard are weighted less than those sounds that are well-heard. This technique will be applied separately and distinctly for each species.

Such a methodology may be able to be applied here for a better understanding of the potential net noise impact on marine animals from the project source transmissions, as follows:

a. For the Kauai study area, the normal background broadband noise will be monitored *in situ* (24 hrs/day with the source-mounted VLA, systematically and opportunistically with the vessel-based VLA and possibly with sonobuoys). Ambient noise models can also be used to provide values; for example: 1) Historical Temporal Shipping (HiTS) noise model, and 2) Directional Ambient Noise Estimation System (DANES). The *in situ* measurements are somewhat different from normal ambient measurements, because it is desired to measure the net energy effect of transients: ships, boats, jet-skis, aircraft, thunderstorms, etc.

b. Monitoring will continue during all experimental transmission periods, such that a source of additional noise energy during these periods will be the transmission itself, plus whatever other noise-producing devices are present at the time. Because the additional noise-producing devices are expected to be operated in a semi-continuous manner during test periods, noise averages with and without project source transmissions can be made in genreal (except for the source-mounted VLA which cannot record during the 25 min of the transmission period) to determine the net impact on Leq.

c. Hearing thresholds in the low frequency band (particularly the project source bandwidth) will be tabulated. Where thresholds have not been measured, best estimates will be made using the range of their known vocalizations, and it will be assumed that their best threshold is the lowest natural ambient at the center of the band.

d. The thresholds will be convolved with each of the Leq measurements made to determine the net impact of project source transmissions on exposed animals. The various uncertainty distributions would also be convolved to evaluate compounded uncertainty in the Leq.

3. Transmission Loss (TL) Model Capability.

In addition to direct measurements of sound levels near marine animals in the study area, there is a need for semi-empirical sound propagation modeling capability on-site in the field, on a near real-time basis. This will allow the marine mammal biologists to take into account the site- and time-specific empirical data in site-specific TL models. A Parabolic Equation (PE) model will be available on one of the workstations located at the Princeville house to determine what received levels to expect for animals at different ranges and depths from the source. These data will be compared with the measured levels, taken with the vessel-mounted VLA, and from sonobuoy data, as feasible. The model will be updated whenever CTD or XBT data are made available. At low frequencies, the most significant effect on accuracy will be the bottom loss values in the model's environmental data base. If possible, these values will be updated based on actual measured transmission loss data collected *in situ*.

C. Shore-Based Visual Surveys

During humpback season the north shore observation station will be located at:

- East of Princeville Makai Golf Course, at the end of Punahele Road at 22°13'43"N, 159°29'13"W at a height of 47 m.

The study arena for focal behavior observations and scan samples (see below for definition of scan samples) is a circle with a radius of approximately 4-10 km centered on the observation station. However, focal pods will be tracked out to 6-8 km from shore, dependent on observation conditions. Non-focal pods and vessels will be tracked up to 8-10 km from shore, dependent on observation conditions. See below (Observation [Focal Behavior Session]) for clarification of focal vs. non-focal pods.

1. Detection and Tracking of Mysticetes, Odontocetes and Sea Turtles; and Other Noise Sources.

Apparatus

Two surveyor's theodolites (Lietz/Sokkisha Models DT5 and DT5A, 10 sec precision, 30x magnification) will be used at the shore station to track marine animals and other noise sources. The theodolite measures horizontal bearings and vertical angles of target locations in degrees, minutes, and seconds. Horizontal bearings are referenced to a charted land mark. Vertical angles are referenced to the gravity-based leveling device on the theodolite. Subsequent analysis converts these angles into Cartesian coordinates for calculation of speeds, direction of travel, and distance among animals and other noise sources, with correction for curvature of the earth. Since fluctuation in tidal height off the Hawaiian coast is less than 30 cm, the minimal resultant error can be ignored (Bauer, 1986). Theodolite-measured target positions (fixes) are taken when the cross-hairs of the scope of the theodolite are positioned with the waterline of the target. To control for error, the horizontal and vertical reference points are checked approximately every 30 min and are reset if out of vertical balance or if off by >1 min of horizontal arc. The theodolite height above the set ground-marker is measured each day.

Fujinon (7x50) or Steiner (15x80) binoculars equipped with reticles and a built-in magnetic compass are the primary eyepieces used to track animals and other noise sources. Big Eye (25x) binoculars will also be used for detailed observations. Reticles are used to gauge distance of animals from the land station based on a formula using known height and associated distance to the horizon (Brueggeman et al., 1992). Time-event recorders (laptop field computers), which automatically assign a real-time flag to each computer entry, are interfaced with the theodolite and are used to record behavioral codes and theodolite fixes.

Observations (Scan Samples)

Each day begins with a scan sample. Successive scans will be separated by at least 1 hr. Scans can be aborted at the discretion of the field site team leader in order to initiate a focal behavioral session.

In order to maximize the ability to detect animals in the short period of time, the scan area is divided into two areas: onshore and offshore, and these are scanned by two different observers. The nearshore observer scans left-to-right, alternating between naked eye and 7x50 binoculars out to the 200 m isobath. This equates to a radius of approximately 5 km from the Princeville station.

The offshore scan is designed to monitor any animal species, particularly deep diving species (e.g., pilot whales, sperm whales) near the source site. To cover the area near the source, an arc is designated from the shore station. The arcs allow maximum coverage of the 10 km radius around the source site, but are small enough to allow multiple left-to-right scans during the 15 min period. The offshore observers scan from the 200 m isobath out to the horizon. This equates to a 64° arc from 282° to 346° magnetic (the arc is centered over the source site), from 5 km out to the horizon.

Scan information is recorded on a separate scan data sheet. All notes and other noise source descriptions are recorded on the scan data sheet and then transcribed to the regular field note form. Environmental conditions (Table C-2) are noted separately on the scan form for nearshore and offshore scan areas on the scan data sheet. The sightability (Vis) and Beaufort

SHORE ENVIRONMENTAL CONDITIONS AND RATING CODES 1993-95

ENVIRONMENTAL CONDITIONS:*

CODE	NAME	DEFINITION
VIS	VISIBILITY	scale: 1=excellent, 2=very good, 3=good, 4=fair, 5=poor, 6=unacceptable (see visibility definitions).
BF	BEAUFORT	Beaufort sea state (see Beaufort definitions)
CC	CLOUD COVER	percent of study area covered by clouds.
GL	GLARE	percent of study area covered by moderate to severe glare, which affects ability to sight whales. Also note the "section" within which glares occur. A section = each quarter of the study area beginning to the left and looking clockwise. There are 4 sections total.
SH	SWELL HEIGHT	estimated in meters.
SP	SWELL PERIOD	time between successive swells in seconds.

*Note: entered in the initial header (HEADH) and every hour on the hour in the update environmental header (HEADE)

Table C-2 MMRP shore environmental conditions and rating codes 1993-1995 conditions are described for the majority of the study area. If necessary, sub-sections of the study area are described separately (e.g., lee of Beaufort 3 <1 km from shore; Beaufort 3 in Section 4 of nearshore scan, etc.).

The scan begins with an "other noise source" scan which is performed by the theodolite operator. All potential noise sources <10 km from the shore station are fixed with the theodolite and their orientation and state (travel, stationary) are recorded. Any additional noise sources that enter the area during the scan are also fixed and tracked. All aircraft passing directly in front of the shore station within 5 km of shore at <610 m altitude during the 15 min animal scan are also recorded on the scan form, and later coded into the computer. Particular attention will be given to vessels that approach within 4 km of the MALOLO during VLA recording sessions. These vessels will be tracked continually by theodolite.

The visual noise source data collected by this primary observation technique will be integrated with the other visual noise source data (from aerial surveys and observations, and from vessel-based visual monitoring), to be convolved with the acoustic noise source data (from the source-mounted VLA, the vessel-based VLA, and sonobuoys). This will facilitate the production of an updated calculation of the contribution to the local ambient noise field from non-ATOC sources.

During the scan for other noise sources, the primary observer scans the area out to approximately 500 m from shore with the naked eye and 7x50 binoculars for sea turtles. The notetaker records the time the sea turtle scan begins and the total number of sea turtles sighted by species on the scan form.

Once the preliminaries are completed, the notetaker starts a 15 min timer and enters the code to designate starting the scan, and the scan for marine animals begins. The nearshore and offshore scans are conducted simultaneously. Observers do not alert one another about the presence of animals outside their designated scan area. The notetaker/computer operator does not participate in locating or alerting anyone about animals to maintain a consistent effort. When an animal or pod is sighted by a designated observer, the theodolite operator obtains additional fixes, attempting to obtain at least 1 fix per surfacing bout.

When an observer sights a pod/animal(s) of interest, he/she dictates the reticule and bearing location to the notetaker. The observer continues to monitor the pod through the binoculars for a surface duration in order to determine species, estimate pod size, and orientation. After the scan observer sights a pod/animals, the theodolite operator takes a fix and follows them to confirm pod size/composition and orientation. The theodolite operator continues to fix pods/animals previously sighted by observers, but not unannounced pods/animals, which might alert observers.

At the end of the scan, a 10 min recovery period is used by the observers and the theodolite operator to confirm animal/pod compositions and to obtain theodolite fixes on animals/pods sighted during the scan, but not fixed.

Because the scan is a point sample of short duration, one cannot truly determine a behavioral state at this point in the protocol procedures. Thus, only orientation and whether a pod was surface active are recorded during the scan when the pod/animal is first sighted.

Observations (Focal Behavior Sessions)

Focal observation sessions are intentionally biased toward individual animals and smaller pods, based on the belief (from previously collected humpback whale observational data) that these are more sensitive to, or would show more reaction to, a disturbance. Class A animals/pods are preferentially selected for observations, all other factors being equal, as follows:

CLASS A	CLASS B
1. Mother/Calf	5. 3 Adults
2. Mother /Calf/Escort.	6. >3 Adults
3. 2 Adults	
4. 1 Adult	

Pods/animals within a reliable viewing distance of a shore station (generally <10 km using 7x-10x binoculars) are selected as focal pods (Bauer, 1986; Helweg, 1989). However, the addition of Big Eye (25x) binoculars increases the reliable focal viewing distance. Collection of accurate behavioral data, particularly surface-dive blow rate (or blow rate), which is used as an index of potential disturbance, usually dictates selection and duration of focal sessions. Moreover, small pods, particularly those containing a calf, show more behavioral responses to disturbances (other noise sources) than do larger pods (Bauer, 1986).

Prior to beginning a focal behavior session, the behavioral state, confidence rating, speed, and disturbance rating are recorded (Tables C-3, C-4, C-5). Focal sessions are initiated after assessing the animals/pods within view of the shore station. Selection of focal animals/pods are prioritized as listed above, while considering the goal of tracking focal behavior as long as reliably possible (e.g., animals just entering the viewing area generally generate longer focal sessions). Table C-5 data recorded will include the identification of MMRP vessels and aircraft and their activity. Also with respect to Table C-5, it is recognized that animal disturbance must be a function of the time-varying radiated noise field, which will vary from vessel to vessel, vessel operating characteristics, and over different acoustic propagation conditions. The potential disturbance categories for vessels and aircraft in this table do not imply that it is known what level of noise disturbs the animals being observed (rather, whether any disturbance is being observed)--in fact, this unknown is the very basis for the proposed MMRP. Nevertheless, from theodolite tracking and observation of targetted vessels, the following pertinent information can be gleaned: 1) range, 2) description of vessel and power plant type, 3) speed, and 4) behavior of vessel (number of course/speed changes). Ideally this data would be suplemented by an acoustic recording of the vessel whereby its source level could be estimated. This will necessarily have to occur on an opportunistic basis (via the source-mounted VLA or with sonobuoys).

SHORE BEHAVIOR STATES 1993-95

Computer Function Keys

Key No	Code	Name	Definition
F1	rest	REST	indicated when a whale(s) lays horizontal and motionless near the surface in the same location for 5 sec or more.
F2	mill	MILLING	swimming with no obvious orientation (non-directional) characterized by asynchronous headings, circling, changes in speed, and no surface activity.
F3	trav	TRAVELING	swimming with an obvious orientation (directional), constant speed, no surface activity.
F4	stat	STATIONARY	little or no forward movement (<1 km/hr) between surfacing sequences, staying in the same general location (singers and tail-sailers fit in this state).
F5	smil	SURFACE ACTIVE MILL	non-directional swimming with the occurrence of aerial behavior that creates a conspicuous splash (include all head, tail, pec fin, and leaping behavior). This is also an *event* for non-focal pods.
F6	strv	SURFACE ACTIVE TRAVEL	directional swimming with the occurrence of aerial behavior that creates a conspicuous splash: This is also an *event* for non-focal pods.
F7	asyn	ASYNCHRONOUS	pods with respiration patterns out of synchrony where a whale(s) blows greater or less than 5 sec. from other whales (e.g., 2 whales surface and blow together while the other whale blows 5 sec later). During extended pauses (dives) try to make a *NOTE* of the number of asynchronous whales and their approx. distance from the core group. Not pressing the asyn function key will indicate the default that all whales in the pod are synchronous in their respiration's.

***Note:** record approx. speed and compass direction when possible in the HEADS header.

0 = not moving forward
1 = slow (no wake, 1-2 km/hr)
2 = medium (small wake, 3-5 km/hr)
3 = fast (large wake, > 6 km/hr)

Events are instantaneous, while states have appreciable duration (Altmann 1974).

**Behavior States modified from: Baker et al. 1982, Würsig et al. 1984, Bauer 1986, and Richardson et al. 1991*

Table C-3 MMRP shore behavior states 1993-1995

BEHAVIORAL OBSERVATION CONFIDENCE RATINGS:

CODE	DEFINITION
1	Excellent respiration and behavioral data (confident that you are missing none).
2	Excellent respiration and "soft" behavioral data (confident you are seeing blows, but you may be missing some behaviors (<10%), usually due to distance or environmental conditions).
3	Okay respirations (you think you're getting most blows) but shaky behavior (you feel you are unable to discern some (<25%) behaviors, generally due to distance or conditions).
4	Shaky respirations (the data will probably be useful only for surface and dive times) and only very obvious/conspicuous behaviors visible.
5	Theodolite tracking only due to inability to discern blows and behaviors usually due to distance or conditions.

*Note: entered in the binocular reticle conversion + rating header (HEADR).

Table C-4 Behavioral observation confidence ratings

SHORE POTENTIAL DISTURBANCE CATEGORIES 1993-95

EXPERIMENTAL CONDITIONS (expt=computer 4-digit code):

Potential Vessel Disturbance:

U	(0)	Undisturbed (vessels > 4 km)
P	(1)	Potential Disturbed (vessels > 1 km and < 4 km)
D1	(2)	Type I Disturbance (vessels < 1km, passing by)
D2	(3)	Type II Disturbance (vessels < 1 km and actively following)
D3	(4)	Type III Disturbance (our research vessel < 1 km engaged in photo ID work)

*Note: these categories are broad classes of visual vessel proximity and their behavior to the focal whale(s). A 30 min buffer will be applied prior to each entered code (e.g., If U then D1 and back to U edited data will add 30 min to D1's duration). Re-evaluation of these "flags" (separate codes) will be made in the final analysis when theodolite fixes have been determined.

Potential Aircraft (airplane & helicopter) Disturbance:

U	(0)	Undisturbed (all aircraft ALT > 1500 ft or 457 m)
PP	(1)	Potential Disturbed airplane (ALT > 800 ft and < 1500 ft)
DP1	(2)	Type I Disturbance airplane (ALT < 800 ft and passing by)
DP2	(3)	Type II Disturbance airplane (ALT < 800 ft and actively circling
DP3	(4)	Type III Disturbance airplane (ALT < 800 ft and blatant harassment)
PH	(5)	Potential Disturbed helicopter (ALT > 800 ft and < 1500 ft)
DH1	(6)	Type I Disturbance helicopter (ALT < 800 ft and passing by)
DH2	(7)	TYPE II Disturbance helicopter (ALT < 800 ft and actively circling)
DH3	(8)	Type III Disturbance helicopter (ALT < 800 ft and blatant harassment)

*Note: these categories are broad classes of visual aircraft proximity and their behavior to the whale(s). A 15 min buffer will be applied prior to each entered code.

Potential Transmission Disturbance:

U	(0)	Undisturbed (no transmission)
P	(1)	Potential Disturbed (now none, but transmission < 30 min ago)
D	(2)	Disturbance (present now)

Potential Military Transmission Disturbance: (Note 1)

U	(0)	Undisturbed (no transmission)
P	(1)	Potential Disturbed (now none, but transmission < 30 min ago)
D	(2)	Disturbance (present now)

*Note: in order to make unbiased and "blind" observations of the effect of. Military transmissions, times will be confirmed after the field season by hydrophone array <u>or</u> assumed based on reported Scripps times and incorporated into data analyses.

Modified LGL Coding and File Formats for Bowhead Behavioral Data (Richardson et al. 1991) and personal communication with Dr. Gordon B. Bauer (10/11/93).

Note 1: Military transmission refers to U.S. Navy active sonars onboard or deployed from ships, and deployed from aircraft (sonobuoys).

Table C-5 MMRP shore potential disturbance categories 1993-1995

Focal observation sessions are comprised of the behavioral observer following the focal animals with 7x50 Fujinon binoculars. The observer calls out the first surfacing of the focal animals, then all of the subsequent behaviors. The final dive is called with a special code to facilitate respiration analysis. The theodolite operator tracks the focal animals, other animals/pods in the area, and all other noise sources within 10 km of the focal animals.

Focal observation sessions are continued on the same animals as long as possible. The longer sessions are specified in attempting to follow the same animals/pod prior to, during, and after a source transmission, and to provide good baseline sessions of similar duration. Sessions generally continue until one of the following occurrences:

- Animals pass beyond reliable viewing range (up to 10 km).
- Animals are lost from view (e.g., obstructed by tree, not sighted for >40 min).
- Conditions are such that behaviors and/or respirations can no longer be reliably observed (poor visibility or SS>5).
- ID confusion with other animals/pods.
- Animals/pod is reliably passed off to other shore station's behavioral observer.
- An affiliation/disaffiliation occurs.

Every attempt is made to follow focal animal respirations out to 10 km and beyond with the Steiner 15x or Big Eye (25x) binoculars.

Focal sessions on Class A animals/pods are continued until behavior is untrackable (weather, distance, affiliation, disaffiliation). If an observation of a Class B pod is less than 30 min in duration when a Class A is sighted, the observer ends the Class B session, and begins anew with the Class A animals/pod. If the Class B pod has been under observation for longer than 30 min, the observer stays with it.

If a pod composition changes during the focal session (animal[s] join or depart the pod), it is given a new identification number (but linked to the original pod identification number) and is treated as a new pod. If focal observations are continued on the "new" pod, an affiliation or disaffiliation computer code is entered to indicate when the affiliation or disaffiliation occurred. Later, a full session header is inserted at that point in the behavioral record.

Each focal animal/pod observation is assigned a rating code to reflect the behavioral observer's confidence in the data collected at the beginning and end of the focal session. This rating may change over the course of a single focal observation session.

All small vessels (<23 m) are tracked out to 10 km by the theodolite operator whenever possible. Larger vessels (≥23 m) are tracked as long as they remain in view. The theodolite operator is responsible for calling closest point of approach (CPA) of vessels and aircraft during focal sessions. Vessel CPAs are called when they are <4 km from the focal animals/pod.

Aircraft CPAs are called when they are at an altitude <610 m and within 1 km horizontal distance from the focal animals/pod. The type of fixed/rotary wing aircraft is recorded and if thought to be harassing any animals, the registration number is recorded as well.

Bathymetric data are being incorporated into the theodolite tracking computer program, which will facilitate water depth vs. dive time estimating.

See Appendix G for details of the results of the 1993 and 1994 shore-based survey efforts.

D. Aerial Behavioral Observations

1. Detection and Tracking of Mysticetes, Odontocetes and Sea Turtles.

Continuous aerial focal animal behavioral samples can be used to provide detailed information about marine animal behaviors and inter-animal interactions (Altman 1974). If conditions permit, the MRT can follow animals for up to 6 hr, providing long, continuous series of surfacing and diving bouts and information on behavioral states. These data can be used to determine changes in responsiveness over time and to calculate time-activity budgets of individuals.

Methodology

The aircraft will be flown at an altitude of approximately 457 m (1500 ft), well above the 305 m (1000 ft) disturbance level set by law, but low enough that animal behavior can be observed accurately. The primary study area will be focused on the 120 dB sound field (see EIS Section 2), and will be limited to data collection when wind conditions are Beaufort 4 or less (<28 km/hr). The timeframe for humpback season aerial observations will be December through April, totaling approximately 60-80 hr. During the Pilot Study period with no humpbacks present, aerial observations will be incorporated with aerial survey flights. The best opportunity for uncontaminated data collection will be during the morning hours when the seas tend to be lowest. If good weather conditions persist into the afternoon, the MRT Leader will decide if a second flight is warranted on that date.

Aerial observations differ from aerial surveys in that the former specifically entail concentrated study in a designated area (in this case the sound field). The platform for the observations will be a twin-engine, high fixed-wing aircraft (Cessna 337). The flight crew will consist of a pilot and 3 photographers/observers. Two of the observers will be on watch at all times, seated on the left and right of the aircraft, respectively, and will observe an area out to approximately 3.7 km (2 nm) on each side of the aircraft's flight path.

Opportunistic observations of animals during the aircraft's transit to and from the study area will also occur. Upon arrival in the study area, the aircraft will begin searching for animals within a 3-5 km radius of the source position. If animals are sighted, focal sampling will begin and continue until the observation team leader decides to break off. The aircraft will orbit each pod of animals (or individual animal) encountered to account for numbers of animals, swimming direction and speed, and other behavioral patterns. Photographs and/or video will be taken on order of the observation team leader. If no animals are sighted within 5 km of the source site, the aircraft will contact the vessel on station, or the Princeville house, to ascertain if any other team has contact with animals of interest. Otherwise, the aircraft will fly pre-planned tracks throughout the sound field using contiguous 7.4 km (4 nm)-wide bands.

Aerial observations will be biased toward small (<3), and mother/calf, groups. This is because individual behaviors are difficult to determine in large groups and there is a particular interest in gathering data on mothers and calves.

The location of all pods/animals observed will be noted on charts with aircraft positions verified with Trimble GPS and/or Loran. These data will be uploaded directly into a portable laptop computer.

Observations

The aircraft pilot will be responsible for keeping the focal animal(s) in the center of the circle flown by the plane, which will usually be banked toward the target at all times. Relative animal positions are estimated based on a series of GPS readings during each complete ellipse of the plane's path. Positions will be read when the plane is oriented in the same direction as the focal animal(s), while the horizontal distance of the plane to the animal(s) is estimated visually. When observing a pod of whales, a second position can be taken when the plane is at the opposite side of the pod (oriented opposite to the pod) so that the actual pod location can be estimated by interpolating between the two locations. The pilot will be monitoring the aircraft altimeter frequently to ensure that altitude does not shift significantly during the observations.

When the focal animal(s) dive at the end of a surfacing bout, the circle of the aircraft will be widened and shifted in the direction of the travel of the animal(s) to allow observers to detect the animal(s) when they first surface at the beginning of the next bout. A fluourescein dye marker may be launched from the plane periodically to provide the pilot with a quasi-fixed reference point. During the dive period, all observers will be scanning around the aircraft to increase the chances of spotting the first surfacing.

During surfacings, behaviors will be reported by the two observers with supplementary information provided by the pilot and videographer. Observations will be recorded onto audio tape and on the audio track of a Sony TR101 image-stabilized Hi-8 video recorder. The observation team leader is responsible for keeping the focal animal(s) constantly under observation, and reporting time and behavior of each animal whenever it is at the surface. He/she will usually be using binoculars during most observations. The secondary observer will describe animal status relative to other potential noise sources (ship, boat, thrillcraft, plane, helo), the shoreline, and other animals in the vicinity. The secondary observer also provides backup for missed data.

The following data are recorded during each surfacing:

- Surfacing time (time each animal appeared at or near the surface).
- All blow times of whales.
- Estimated swim speed.
- Location at first and last surfacing.
- Animal(s) orientation at first and last surfacing.
- Relative distance between animals when in a pod/group (reported in body lengths).
- Relative orientation between animals.
- Animal(s) behavior (Table C-6).

The third observer is responsible for providing backup information, searching around the aircraft for other animals in the area, and for video-taping events, as directed.

Data Reduction and Analysis

All the recordings of each day's observations will be transcribed onto a data form designed to indicate the time-course of events. The transcripts will then be checked against the video recordings to ensure that the sequence of behaviors is complete for each animal at each surfacing, that observers have correctly identified behaviors for each individual observed, and to obtain data on inter-individual distances and relative orientation throughout the surfacing sequence. Video tapes will be projected for analysis on a high-resolution 27-inch Sony Trinitron XBR television monitor (S-VHS type) from a Sony EVS 9000 Hi-8 video deck, capable of frame-by-frame examination of the tape.

Transcriptions will be checked for completeness and accuracy before they are encoded for computer analysis. The transcribed data are then entered into a data base, including behavioral parameters that can provide important information about potential disturbances. The resultant ethogram is very detailed, facilitating future work of pooling behavioral categories.

These data will be used to calculate derived variables such as duration of surfacing. If the first surfacing was not observed because the animal(s) came up at an unexpected location, several derived variables cannot be included, such as surfacing interval, duration of surfacing, and dive duration. However, all behavioral characteristics collected while the animal(s) were at the surface can be included. Previous observation studies (Bowles, unpub., 1993) have noted affiliations and disaffiliations as being common, and at times whales alter their behavior in response to breaches or other surface activity by distant whales. Therefore, it is not always possible to predict the location of a surfacing following a dive, even though the water may be clear enough that animals would ordinarily be seen well before they broke the surface.

COMPUTER TRANSLATIONS FOR AERIAL ETHOGRAM 1993-95

Computer Number Codes (NC) & Field Letter Codes (LC)

RESPIRATION:

01	FS	First Surface with No Blow
02	F	First Surface Blow
09	NF	Not First Surfacing? (whale seen at surface)
03	B	Blow
05	N	No Blow Rise (surface w/ no visible blow)
04	M	Missed Blow(s)? (breaks resp. sequence)

SUBMERGENCE:

10	S	Slip Under (terminates rest bout)
06	A	Peduncle Arch (arching w/out lifting flukes)
08	D	Fluke Down Dive (arch and lifting flukes < 45 deg)
07	U	Fluke Up Dive (arch and lifting flukes > 45 deg)
15	SO	Unidentified Submergence > 60 sec (?)

NON-RESPIRATORY MARKERS:

12	NR	Missed Non-Resp Beh(s)? (breaks beh. sequence)
11	UB	Unidentified Behavior? (any NR not included below)

SUBSURFACE EXHALATIONS:

13	BC	Bubble Cloud (single burst of bubbles)
14	BT	Linear Bubble Trail (stream of bubbles)

WHALE VOCALIZATIONS:

20	SR	Singing Reported (by research vessel)
21	SS	Singing Stop

HEAD & LEAPING BEHAVIORS:

41	HR	Head Rise (Spyhop)
43	HL	Head Lunge (forward thrust < 45 deg)
45	MB	MotorBoating (S-shaped swim > 3 sec)
46	HS	Head Slap (forward thrust > 45 deg & slap w/ no twist)
47	BR	BReach (leaps out to peduncle w/ twist)
48	US	Unidentified Large Splash?
49	OH	Other Head Behavior?

TAIL BEHAVIORS:

51	TE	Tail Extension (holds in air > 3 sec)
52	TS	Tail Slap (slapping w/ ventral surface)
54	LS	Lateral Tail Slap (peduncle slap)
55	SW	Tail SWish (side-to-side motion)
56	LT	Lateral Tail Display
59	OT	Other Tail Behavior?

PECTORAL FIN BEHAVIORS:

61	PE	Pec Extension (1 or both fins > 3 sec)
62	PS	Pec Slap (form unspecified)
63	LPS	Lateral Pec Slap (whale on its side)
64	VP	Ventral Pec Slap (whale belly-up)
65	RP	Rolling Pec Slap (rotating rostro-caudal axis)
68	OP	Other Pec Behavior?

BODY CONTACT:

74	SB	Striking with any Body Part
75	WC	Whale Body Contact
76	WU	Whale Under another Whale

HEAD, LEAP, TAIL, PEC, BODY MODIFIER:

70	DTM	Directed Toward Mom (modifier)
71	DTC	Directed Toward Calf
72	DTE	Directed Toward Escort
73	DTW	Directed Toward nearest Whale(s) (age unknown?)
77	DTV	Directed Toward nearest Vessel
78	DTU	Direction unspecified? (default for away)

*AGE MODIFIERS. FOCAL WHALE SAMPLING:

1NC	LC1	Adult (default, just enter beh. letter codes)
2NC	LC2	Mom
3NC	LC3	Calf
4NC	LC4	Escort

BEHAVIOR STATES:

1	rest	REST
2	mill	MILLING
3	trav	TRAVELING
4	stat	STATIONARY
5	smil	SURFACE ACTIVE MILL
6	strv	SURFACE ACTIVE TRAVEL
7	adsc	ADULT SOCIAL
8	mcsc	MOM/CALF SOCIAL

*Note: see behavior state definitions for detail.

FOCAL POD EVENTS:

579	PD	Pod Decreases Speed
580	PI	Pod Increases Speed
581	PX	Pod Stops (X)
582	P45	Pod Changes Direction > 45 deg
583	P90	Pod Changes Direction > 90 deg

FOCAL VESSEL(S) EVENTS:

986	V45	Vessel Changes Direction > 45 deg
987	VX	Vessel Stops (X)
988	VS	Vessel Starts
989	VC	Vessel Changes Speed Notably

*FOCAL POD AFFILIATIONS/DISAFFILIATION:

569	PAF	Pods Affiliate (2+ join to form one)
570	PDS	Pods Disaffiliate (pod Splits)
571	SAF	Suspected Affiliation
572	SDS	Suspected Disaffiliation

*Note: a pod equals whales < 5 WLU.

LOST FOCAL POD/END SESSION:

500	PU	Pod Identification Number Uncertain?
597	PL	Pod Lost -- Note any Reason?!

BEHAVIOR RECORDING AIDS:

000	L	Lag (3 sec) in calling beh
0##	L##	Lag (+ no. of sec) in calling beh
999	X	Delete previous entry (X)
222	XX	Delete last sequence of entries (XX)

POD MODIFIERS & NONFOCAL SAMPLING:

6##	H##	Helicopter + ID no.
7##	AP##	Air Plane + ID no.
810	CA	Closest Point Approach (CPA, call < 1000 m)
815	SP	SPinner dolphin(s)
825	BN	BottleNose Dolphin (Tursiops spp.)
835	TU	Sea TUrtle(s) (green)
845	OS	Other Species (ID species as comment)

**Ethogram modified from: Baker et al. 1982, Würsig et al. 1984, Bauer 1986, Richardson et al. 1991, & Kewalo Basin Marine Mammal Laboratory.*

*Note: for computer analyses age modifiers & 2-digit beh number codes are split into separate columns (age & beh), all non-beh. 3-digit codes are placed in the same column with beh. codes, and behavior states are places in separate column (beh state).

Table C-6 Computer translations for MMRP aerial ethogram 1993-1995

The data will be analyzed according to the methods of Richardson et al. (1986). The variables that will be examined will include the following:

- Dive times
- Surfacing durations
- Blow intervals (for whales)
- Blow rate per surfacing (for whales)
- Swim speed (from surfacing to surfacing)
- Animal(s) orientation during surfacing
- Reorientation rate during surfacing (measure of number of changes in direction during a surfacing)
- Relative orientation and inter-animal distances.

2. Received Level (RL) Acoustic Measurements via Sonobuoy.

In addition to standard aerial survey and observation procedures, the aircraft would monitor and record vessel data in the study area, and deploy sonobuoys (e.g., Magnavox AN/SSQ-57A [SPL]) on an opportunistic basis to record cetacean vocalizations, and ambient noise (including vessel noise) and source received levels in the vicinity of marine animals being observed. This technique would be particularly beneficial when observations are underway in areas where there is no other effective way to measure received signal level at the animal(s) under observation. If utilized, sonobuoys wouldbe deployed > 400 m from the animal(s) to minimize any potential disturbance caused by the sonobuoy itself. Recordings of the signal from the sonobuoy would be made with a TEAC RD101T DAT recorder equipped with an anti-aliasing filter. The signal would be received on an ICOM7000 radio receiver connected to an externally-mounted antenna on the aircraft. Recordings would be made continuously after the sonobuoy enters the water until the aircraft is out of range of the buoy.

The visual and acoustic noise source data collected by this primary observation technique will be integrated with the other visual noise source data (from aerial surveys and from vessel-based visual monitoring), to be convolved with other acoustic noise source data (from the source-mounted VLA and the vessel-based VLA). This will facilitate the production of an updated calculation of the contribution to the local ambient noise field from non-ATOC sources.

E. Aerial Surveys

Aerial surveys are a very important part of the MMRP, both for marine animal distribution information, and for the necessary interface with the aerial behavioral observation task. With enough aerial survey data available, there should be sufficient power to estimate numbers and distribution for a suite of marine animal species, particularly humpback, sperm and pilot whales; and spinner, spotted, and possibly bottlenose dolphins.

During January-April 1993, four aerial surveys (14 flights) were conducted that included inter-island statewide surveys of waters surrounding the major Hawaiian Islands. Survey tracklines followed north-south systematic lines spaced 26 km apart in channel areas, 13 km apart in major island regions, and 6.5 km apart in the source site area off the north shore of Kauai. See Appendix G for 1993 aerial survey results.

During January-July 1994, aerial surveys (13 flights) were concentrated on Kauai, using the same line spacing protocol. Appendix F gives the results of these efforts.

1. Population Counts of Mysticetes, Odontocetes, Pinnipeds and Sea Turtles; and Other Noise Sources (Study Area and Statewide).

Aerial surveys for the 1995-96 Pilot Study (including the time prior to humpback season and during humpback season) will follow line transect protocol used in the 1993, including inter-island statewide flights, and early 1994 surveys to ensure comparability of data sets.

Aerial surveys will be conducted from a twin-engine, high-wing aircraft (Cessna 337, which will be the same aircraft used for the aerial behavioral observations). It is equipped with Collins ALT 50A radar altimeters and Morrow Apollo GPS receivers that output to a Compudyne 386 laptop computer. This system automatically records positional data at 30 sec intervals and manually records whenever a sighting is made. Sighting angles to target animals/pods are made using a Suunto (Model PM-5) hand-held clinometer with analog display, calibrated to whole degrees. These angles, in combination with the altitude data, allow for the estimation of perpendicular distance from the sighting to the transect line. Given the average recorded altitude of 250.5 m (sd = 35.66 m), errors of $\pm 1°$ of angle yield theoretical distance estimation errors on the order of 5 m at the minimum sighting angle of 70°, to 1200 m at the maximum effective distance of 3.7 km (sighting angle of $3.87° \pm 1°$).

Each flight is staffed with three survey personnel, which includes two observers and one data recorder, in addition to the pilot. Specific portions of the survey area are assigned to each of two aerial survey teams. All primary staff members are experienced in line survey methods and marine animal identification, with a minimum of two field seasons of prior survey experience.

Proposed 1995-96 surveys will follow north-south tracklines with the same line spacing as that used in 1993-95. Plans are for approximately 4 surveys (4 flights each survey), for a total of approximately 16 flights that will cover the entire north Kauai offshore area, and possibly 6-8 inter-island statewide survey flights.

Random startpoints are used so that the exact trackline configuration of each survey is varied. The systematic lines project approximately 13 km past the 2000 m isobath, with random lines connecting the endpoints. Tracklines are generated using the following ground rules:

- Fly north-south lines 26 km, 13 km, or 6.5 km apart starting with predesignated randomly-chosen startpoints.
- Fly to shoreline, then connect to next systematic line by flying to a point 5.5 km offshore of the starting point of that line.

- All lines must be no closer than 2.8 km from shore, so that both observers have equivalent viewing swaths.

- Add one or two north-south lines in areas of known higher densities of marine animals.

Sightings are made by the two observers, one on each side of the plane, and called verbally to the data recorder seated next to the pilot. When a sighting occurs, observers call out the data in the following order: number of individuals, calf/calves (if present), species, angle to sighting, and reaction to plane (if any). These data are manually noted by the data recorder. At the start of each leg, or when conditions change, the observers also call out environmental information, including glare, visibility, and Beaufort seastate, which the data recorder also enters. The automated data, which indicates real-time latitude and longitude from the GPS receiver, and altitude (to the nearest meter) from the radar altimeter, are automatically written onto the hard disk of the laptop computer, and onto a 3.5 in floppy disk as backup. The manually-logged data are keypunched into an ASCII file and later merged with the computer-written data using customized software.

Since former aerial survey results indicated heterogeneity of animal densities across regions and depths (Baker and Herman, 1981; Mobley et al., 1991; Forestell, 1989; Forestell and Mobley, 1991; Forsyth, Mobley and Bauer, 1991), any inter-island survey results will be stratified by major island region depth with strata as follows:

a. Inter-Island Region Strata:

- Kauai/Niihau
- Oahu
- Penguin Bank
- Four Island Region (Maui, Molokai, Lanai, Kahoolawe)
- Big Island

b. Depth Strata:

- <200 m
- 200-2000 m
- >2000 m

Abundance estimates for animals will be generated using the DISTANCE Program (version 2.03) developed by the National Marine Mammal Laboratory (NMML), Seattle.

During the off-season months (May-November), it is expected that aerial surveys will be concentrated in the source sound field only, on a 1-2 flight/month basis (see EIS Table 2.2.1.1-1).

F. Playback Studies

1. Humpback whales off Kona coast of Big Island

The experimental design incorporates several data collection procedures in concert. In overview, small boats are used for technical support of the 4-element VLA, to deploy the J-15-3 transducer system, and for fluke identification photography. The shore station incorporates visual behavioral observation and visual theodolite tracking to locate and track whales.

The experiment involves a shore monitoring station manned with 4-6 persons, which records the behavior of whales and tracks the movements of whales and vessels. A trial begins when a pod of whales is spotted moving into visual range of the shore station. The vessel is moored in front of the shore station, and the session begins on a surfacing of the pod. Baseline monitoring continues for approximately 25 min, at which time the projector is activated, and shore visual monitoring continues as before. To control for observer effects, a control stimulus (blank tape) would be used as well. The order of presentation of experimental and control stimuli would be randomized. The shore station would remain blind to the sound condition used. Previous playback studies with humpback whales have shown that playback of blank tape does not alter behavior (Frankel, 1987; Mobley et al., 1988). There is no need then to explicitly control for the presence of the vessel, as its presence would be controlled implicitly by the fact that it would be present throughout each trial. The most important control would be for observer effects, rather than the presence of the boat. This would be accomplished with an A-B-C design. Each lettered portion or phase of the experiment would be 25 min long. The baseline (A) phase collects 25 min of pre-test observation, with all sounds absent. The projector is activated in the B phase. The C phase is for post-experiment observation, if possible.

Two behavioral data streams would be collected. The first would be a continuous record of a focal pod. Every behavior that this pod performs would be recorded. A nonfocal *ad libitum* sampling would be conducted for all remaining pods in the area. Theodolite measurements would be taken for every pod seen.

A 12-15 meter vessel would be utilized to deploy the playback equipment. A 5-meter Boston Whaler would be used for deploying an 81 m VLA to collect ambient noise (including other noise sources, and playback source received levels). Recording samples for ambient noise and source received levels would be taken from a set of approximately 20 fixed stations (during transmission and non-transmission periods) during the course of the playback study. Any cetacean vocalizations picked up at this time would also be included in the data sets.

Playback procedures: The boat-deployed acoustic source would be the J-15-3, which is a set of three J-15 electrodynamic (moving-coil) transducers rigged side-by-side, and electrically connected with polarities that insure in-phase acoustic signals. The system includes a power amplifier, calibrated reference hydrophone, and a Dolch 486 laptop data acquisition and control unit. This system allows the simultaneous input and output of playback and received signals. It allows monitoring of output and reference levels from the reference hydrophone, in real-time. The entire system will have been tested and calibrated at either Cayuga or Seneca Lake before being transported to Hawaii. Theoretically, a J-15-3 should provide an omnidirectional source level of approximately 172-175 dB (100 times lower than the operational ATOC source). The system has a frequency range of 30-900 Hz (best frequency response 60-400 Hz), maximum operating depth 165 m, and weighs approximately 284 kg in air. Based on MMRP Advisory Board suggestions, the nominal playback protocol would be standard field study design limited to two test conditions: 1) 5 min ramp-up, then 20 min duration low frequency sound transmissions (tape recording of an actual ATOC source signal) at 75 Hz frequency with a source level near 175 dB, and 2) blank tape control. Similar designs have been successfully used by Tyack (1983), Mobley (1988), and Frankel (in press) in playbacks to humpbacks and by Richardson et al. (1985, 1990) for playback of industrial noise to bowhead whales.

III. REAL-TIME ANALYSIS OBJECTIVES AND SCHEDULE

The Kauai MMRP schedule of events (Table 2.2.1.1-1) lists the timetable for the analysis reports that are to be delivered. The following provide some amplifying information as pertains to the MMRP Pilot Study:

- MMRP Pilot Study Bi-Monthly Status Reports:

- Analysis Objectives: Brief status report on observations to date, including any results from preliminary analysis of data from the research teams. These reports will deal primarily with early assessment of the efficacy of the protocol, and whether any modifications should be made in the near-term.

- Schedule: First report due 60 days after commencement of Pilot Study acoustic transmissions; second report 120 days after; etc. Recipients will be NMFS, ARPA, SIO and the MMRP AB.

- MMRP Pilot Study Quick-Look Report:

- Analysis Objectives: as stated in the MMRP Pilot Study Protocol, including preliminary results from all research teams; collated and prepared under the auspices of the MRT Leader, reviewed and approved by the MMRP Director. This report will deal primarily with any evidence concerning occurrence of acute or short-term effects (Table C-1) that could potentially be attributed to source transmissions.

- Schedule: MMRP Pilot Study Quicklook, including Vu-graph presentation (with hard copies available) to NMFS, MMC, ARPA, SIO, MMRPAB and designated recipients (e.g., Kauai CAG, Earle/Notthoff group, other concerned scientists) within 30-60 days of the conclusion of the MMRP Pilot Study.

- MMRP Pilot Study Final Report for 1995-96:

- Analysis Objectives: as stated in the MMRP Pilot Study Protocol, including final observation and survey results from all research teams; collated and prepared under the auspices of the MRT Leader, reviewed and approved by the MMRP Director. This report will include final analyses of any subtle behavioral reactions that could potentially be attributed to source transmissions, and analysis of statistical power.

- Schedule: MMRP Pilot Study Final Report for 1995-96, including Vu-graph presentation (with hard copies available) to NMFS, MMC, ARPA, SIO, MMRPAB and designated recipients 180 days after submission of the Quicklook.

A. Statistical Methods

Distribution vs. Sound Fields

Two Cornell University-developed computer programs will be used in statistical research. "Canary-500" is the software for processing all acoustically-collected marine animal and other noise source data.

"Aardvark" is the software used for reducing all visually-collected marine animal and other noise source data (surveys and observations) and generating track lines. It is a theodolite data analysis program. Aardvark converts the vertical and horizontal angles measured by theodolite into Cartesian coordinates. It then uses a series of positions of a marine animal (or animals) or vessel/aircraft to build a "track" of its movement. Statistics such as bearing, speed, and milling index are generated from the track. The program then generates statistics between tracks: 1) distance between animals and all other animals and vessels detected, 2) closest point of approach (CPÁ) of the whales and vessels, and 3) a measure of the relative orientation of the other animals relative to the first animal.

Once both sets of data have been combined in the uniform data base, MRT researchers will attempt to generate statistics relative to different marine animals/species and relative to other noise sources. Statistical power analysis will provide more detail on any behavioral responses of the animals. Attempts will be made to overlay bathymetry to make statistical comparisons, and measured noise field data sets can be juxtaposed in order to convolve distribution data with sound field measurements.

Abundance Estimations (Aerial Survey Data)

For abundance estimation, the influence of Beaufort sea state and visibility on sightings of animals will be analyzed. The observed vs. expected number of animals/pods/groups will be analyzed. In the past, the departure from expected frequency has been greatest when sea states were greater than 3, and visibility was coded as "good" or better. Limiting the usable sightings to these condition criteria or better will reduce the total data set (in 1993, it reduced it from 397 to 311).

Since there has, in the past, been no clear drop in sightability of the larger animals (e.g., humpback whales) at increasing distance, a truncation point of approximately 3.7 km has been chosen, such that only 5% of the perpendicular distances remained. Reducing the data set further to only those sightings within 3.7 km would reduce the usable sightings even further (in 1993, this scheme reduced it from 311 to 292).

The perpendicular distance data will be analyzed using the DISTANCE Program (Version 2.03), developed by NMML (1983). Three models will be applied to these detection probability data to determine the best fit, including uniform, half-normal, and hazard rate models. In the past, the best fit has been provided by the hazard rate model (Figure C-1).

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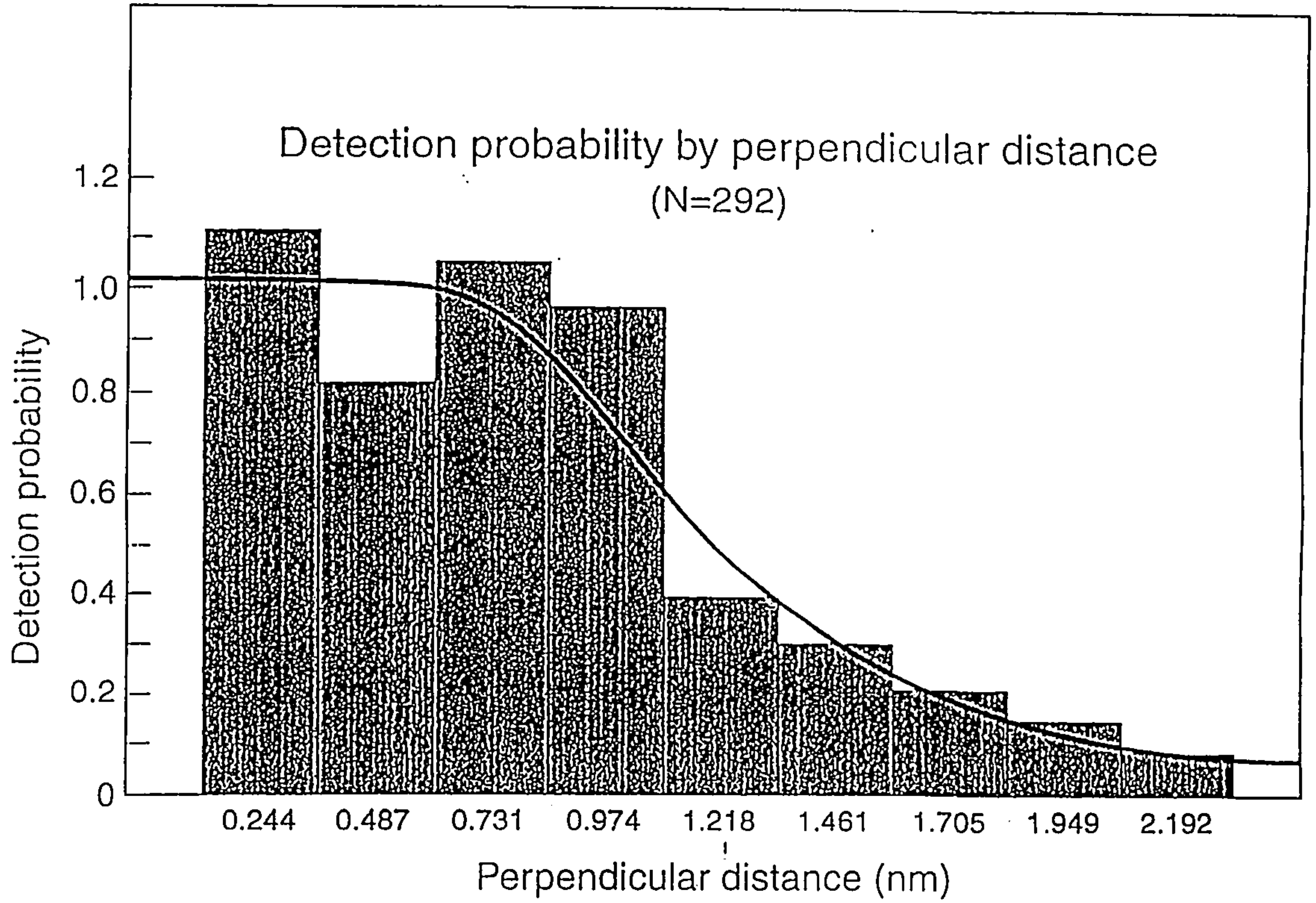

Figure C-1 1993 aerial survey - Humpback whales; detection probability by perpendicular distance

When the abundance estimates are analyzed separately for each flight, a range of coefficients of variation (CV) are produced. These values ranged from 17.3 to 39.0% in 1993. However, when all four flights were combined, the CV dropped to 11.3%. Aikaike's Information Criterion (AIC) provides a quantitative method for model selection. For a given data set, AIC is computed for each candidate model and the model with the lowest AIC is selected (Buckland et al., 1993). In this case, the AIC sum for all four surveys was less than the combined, which suggests differences across the surveys, or it may reflect regional differences in densities and/or observer differences.

For the 1995-96 survey data, the same statistical analysis techniques will be used as were applied to the 1993 and 1994 data. Abundance estimates will be based on a depth stratified line transect approach, using the hazard rate model with encounter rate and density by stratum, detection probability for all data combined, and pooled estimate of density from area-weighted stratum. Estimates from these methods will be interpreted as a minimum estimate, in that they represent the number of animals detectable at the surface. It is not, therefore a population estimate.

Population Estimations

The distance sampling theory upon which DISTANCE and similar programs are based, assume the g(0), or the probability of detection on the trackline to be unity. As Buckland et al. (1993) have pointed out, this assumption is not true for cetaceans, since they are only detectable at the surface for relatively brief time periods. In order to produce a population estimate, one must know the probability that the animals in question will be at the surface at any given time. Different approaches to this problem have been proposed in the past, including using two separate platforms and determining the proportion of overlapping observations, or using respiration data to determine mean surface time. Since the MMRP includes shore station data collection efforts, adjoining the source sound fields, the possibility of deriving a correction factor from these data exists. However, the sources of variance in respiration rates (differences across regions, pod/animal types, and levels of disturbance) must be accounted for before a single correction factor can be applied. It is the goal of the MMRP Research Team to establish a reasonable parameter for humpback detection probability. Detection probabilities for other species will be obtained from research projects outside the MMRP.

IV. STATISTICAL POWER ANALYSES

At issue is whether or not the proposed ATOC MMRP Research Protocol for the Kauai MMRP will have sufficient statistical power to detect significant differences in humpback whale densities and behaviors. Statistical power analyses were conducted for four MMRP research techniques: 1) aerial visual surveys, 2) passive acoustic monitoring with source-mounted VLA, 3) shore-based visual surveys, and 4) cetacean playback studies.

A. Aerial Visual Surveys

This analysis is based on the aerial survey sightings of humpback whales within an approximate 25 km radius of the proposed source site 14.7 km off the north shore of Kauai. These data were collected during 1993-95 and provided by Dr. Joe Mobley of the University of Hawaii. A total of 230 humpbacks were sighted during eleven surveys covering a total of 5477 km of track lines. Sighting rates were obtained for each survey (see below) and mean rate and standard deviation for these data were 0.0410 humpbacks/km and 0.0102, respectively.

Paired t-test

It was decided that the paired t-test may be an appropriate procedure to estimate the paired survey approach. During the timeframe of the aerial surveys (at least 6 months), the population density of humpbacks off the north shore of Kauai will fluctuate due to migration, allowing a determination of the seasonal variability in species distribution, as well as the potential for any ATOC source transmission effects (observed in paired surveys). Therefore, an examination of the difference in sightings between the time just prior to source transmission (two hours prior) vs. the time just after source transmission (two hours after) is appropriate (Green, 1989). In such an approach, the correlation between the before and after data needs to be estimated in order to calculate the standard deviation of the difference of the two means (Zeh, pers. comm., 1995). Fortunately there are many data (aerial visual sightings) from the 1993-95 aerial survey efforts in association with the MMRP to date (232 whale sightings). The results of the calculations are summarized below:

0.9 if the before and after correlation is 0.5. However, it must be noted that humpback seasonality restrictions (see above) would also apply here. Nevertheless, the VLA should prove to be a powerful tool in evaluating the potential impact of the source transmissions on marine mammals in the vicinity. Furthermore, through continuous monitoring of the VLA for low frequency (<1000 Hz) whale vocalizations, a reliable baseline of detection rates and the associated variability will be available under different operating conditions. By taking advantage of this technique, the sample size is effectively as large as the number of transmissions and will also enable the MMRP Research Team to account for seasonal variability in whale density and vocal behavior for vocalizing cetaceans year-round.

C. Shore-Based Visual Surveys and Cetacean Playback Studies

This analysis is based on the shore-based visual detections of two variables from the two sites used as observation perches during the 1993-94 winter seasons: 1) humpback blow rates (number of blows seen divided by the number of whales in the pod and the duration of the *surfacing sequence*), and leg speed (measured speed of the pod). For area coverage and other methodology details, see paragraph II.C of this Appendix and Appendix G. For this calculation, a recorded set of 148 pod sightings over a time period of 545 hrs of observation was selected; although the total number of pods observed during the 1994 season was over 500. Mean values were obtained for each pod. The mean and s.d. were then calculated from these first means (so that the unit of analysis is an observation of a pod); the results are:

Variable	Mean	s.d.
Blow Rate	0.51289	0.29883
Leg Speed	4.01859	2.1531

Paired t-test

Again, it was decided that a paired t-test would be the most appropriate procedure to estimate the paired encounter approach of this methodology. An examination of the difference in humpback blow rates between the time period one hour prior to transmission and the time period one hour after transmission is appropriate. It was assumed that the proposed data collection would be observations of the same pod before and after ATOC source transmissions. Thus the mean and s.d. data were entered into a paired t-test power analysis. The results are listed below:

rho	Power	No. of Paired Animal/Pods Sighted (blowing) Required to Detect a 20%/10% Change in Blow Rate	No. of Paired Animal/Pods Sighted (blowing) Required to Detect a 20%/10% Change in Leg Speed
0.50	0.80	73/291	62/246

Using a two-tailed test with an alpha value of 0.05 and rho of 0.5 (appropriate because of the assumption that the same pod would be observed before and after ATOC source transmissions), a power of 0.80 can be attained for the detection of a 20% change in blow rate with 73 paired sightings; and a 20% change in leg speed with 62 paired sightings. For a more severe criterion of detection of a 10% change in blow rate of the same pod before and after a source transmissions, 291 paired sightings are required; for a 10% change in leg speed, 246 paired sightings would be needed.

These calculations will apply to the shore-based visual survey efforts at both the north Kauai site and for the playback studies to be conducted off the Kona coast of the Big Island.

D. Summary

Based on the above calculations, it appears that a combination of visual and acoustic techniques will be able to detect, with relatively high power, any changes in humpback densities (via aerial visual sightings) and behaviors (vocalization rate/pattern, blow rate, leg speed) between the time when the source is off (just prior to transmission) and immediately after transmission periods.

Whales/Date	Total km flown	Encounter Rate (n/km)	Sub-Group (mean)	Sub-Group (s.d.)
4	129	0.031		
13	602	0.022		
7	144	0.049		
16	601	0.027	0.032	0.01174872
31	574	0.054		
46	645	0.071		
30	581	0.052		
35	599	0.058	0.059	0.00877747
9	471	0.019		
22	564	0.039		
17	567	0.030	0.029	0.00996372
2	417	0.005		
n = 232	5894	11.0000	mean	s.d.
average = 19.33	average = 491.17	average = 0.0410	0.0401	0.0102

rho	Power	No. Paired Surveys Required for Effect Size = 0.50
0.25	0.9	14
0.25	0.8	10
0.33	0.9	11
0.33	0.8	8
0.50	0.9	6
0.50	0.8	4

This table indicates that given this large data set (S.D. = 0.0102) with which to base our calculations, and using a correlation between the before and after periods (rho) of 0.33, with a 0.90 power requirement, and effect size of 0.50--yields the number of paired surveys needed to be 11. That is, there will need to be approximately 6600 km of track lines (see paragraph II.E of this Appendix for survey flight methodology) flown during the two hour time periods before source transmissions and approximately 6600 km of track lines flown during the two hour time periods following source transmissions. This will yield the capability to detect a change of 50% in sightings between the two time periods, with a 0.90 power. The aerial survey team will not be aware of when the source is on or off (either *a priori* or during flights), so the MRT Leader will have to carefully schedule flight hours to optimize the opportunity for collecting sufficient data sets, while maintaining the blindness of the survey team members. This will be complex but attainable.

B. Passive Acoustic Monitoring with Source-Mounted VLA (Detection of Vocalizing Mysticetes)

Paired t-Test

For the vertical line array deployed from the source, the acoustic data stream would be virtually continuous except specifically during the 5 min ramp-up and subsequent 20 min transmission. Values for mean detection rate and s.d. used for the statistical power analysis done for the California ATOC source are also presumed valid for this analysis. Calculations were performed by Cornell University (C. Clark). The results are listed in the table below:

rho	Power	No. Paired Surveys Required for Effect Size = 0.10	No. Paired Surveys Required for Effect Size = 0.20
0.25	0.5	298	75
0.25	0.6	397	99
0.25	0.7	518	130
0.25	0.8	681	170
0.25	0.9	944	236
0.5	0.5	133	33
0.5	0.6	176	44
0.5	0.7	230	58
0.5	0.8	303	76
0.5	0.9	419	105
0.6	0.5	85	21
0.6	0.6	113	28
0.6	0.7	147	37
0.6	0.8	194	48
0.6	0.9	268	67
0.7	0.5	48	12
0.7	0.6	64	16
0.7	0.7	83	21
0.7	0.8	109	27
0.7	0.9	151	38

Because the VLA will be operating continuously, each transmission can be considered an individual on-off evolution; i.e., a determination of any change in the abundance and distribution of vocalizing mysticetes before vs. after each transmission. Thus, six months of Pilot Study effort, with approximately 12 days of transmissions (6 per day) each month, will offer a maximum of 432 paired acoustic detection period opportunities. This yields the ability to detect a change of 10% in acoustic detections between the two hour period before a transmission and the two hour period after the transmission, with power > 0.6, if the correlation between the variances between before and after data is 0.25, or the detection of a 10% change with power >

APPENDIX D

Federal, State and Local Official Correspondence
and
Scoping Comments

Federal, State and Local Official Correspondence

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BENJAMIN J. CAYETANO
Governor of Hawaii

STATE OF HAWAII
DEPARTMENT OF L[redacted]ATURAL RESOURCES
Honol[redacted]809

Chairperson
MICHAEL D. WILSON
Board of Land and Natural Resources

Deputy Director
GILBERT COLOMA-AGARAN

Aquaculture Development
Aquatic Resources
Boating and Ocean Recreation
Bureau of Conveyances
Conservation and Environmental Affairs
Conservation and Resources Enforcement
Forestry and Wildlife
Historic Preservation
Land Management
State Parks
Water and Land Development

REF:OCEA:SKK

In reply, please refer to
FILE NO.: KA-2734
DOC. ID.: 5373

MAR - 6 1995

Mr. Andrew Forbes
ATOC Program Manager
Acoustic Thermometry of Ocean Climate Project
University of California, San Diego
Scripps Institution of Oceanography (0225)
Institute of Geophysics and Planetary Physics
La Jolla, CA 92093-0225

Dear Mr. Forbes:

SUBJECT: Conservation District Use Application KA-2734 for the Acoustic Thermometry of Ocean Climate (ATOC) Project, Offshore of the Island of Kauai

This correspondence is to acknowledge the receipt of your February 23, 1995 letter in which you requested a 90-day time extension to June 25, 1995 for CDUA #KA-2734.

As outlined under the provision in Chapter 183C of the Hawaii Revised Statutes, the 180-day date for CDUA #KA-2734 will be extended 90 days, and will now expire on June 25, 1995.

Thank you for your attention to this matter. Should you have any questions, please feel free to call Roy Schaefer of our Office of Conservation and Environmental Affairs staff at (808) 587-0377.

Aloha,

MICHAEL D. WILSON

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BENJAMIN J. CAYETANO
Governor of Hawaii

Chairperson
MICHAEL D. WILSON
Board of Land and Natural Resources

Deputy Director
GILBERT COLOMA-AGARAN

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. Box 621
Honolulu, Hawaii 96809

Aquaculture Development
Aquatic Resources
Boating and Ocean Recreation
Bureau of Conveyances
Conservation and Environmental Affairs
Conservation and Resources Enforcement
Forestry and Wildlife
Historic Preservation
Land Management
State Parks
Water and Land Development

REF:OCEA:SKK

In reply, please refer to
FILE NO.: KA-2734
DOC. ID.: 5385

MAR - 6 1995

Mr. Raymond L. Chuan
Co-Chair
Kauai Friends of the Environment
P.O. Box 1183
Hanalei, Hawaii 96714

Dear Mr. Chuan:

In response to your correspondence of February 4, 1995 regarding Conservation District Use Application No. KA-2734, for the Acoustic Thermometry of Ocean Climate (ATOC) project, we have the following answers to your three questions.

1. The Department is responsible for the CDUA process and the Environmental Impact Statement process as outlined within Chapter 343 of the Hawaii Revised Statutes. The CDUA was triggered as a result of submerged land use within the Conservation District as defined in section 13-5-2 Definitions for "land use" under part 1 of Chapter 13-5, Hawaii Administrative Rules (Attachment 1).

2. The Horizontal Line array proposal originating from the Wainiha River was withdrawn, only the cable to power the sound source from the Barking Sands site is currently requested as a part of CDUA #KA-2734. As indicated in the Draft EIS, cable was laid by the U.S. Navy in 1983; no CDUA was required because of Federal Supremacy and Sovereign Immunity as outlined in the U.S. Constitution and confirmed by subsequent Court decisions.

3. A public hearing is tentatively scheduled on Kauai for June 8, 1995 for CDUA #KA-2734. Legal notices will be provided prior to this hearing and the Department will provide you with a notice as well.

Please feel free to contact Roy Schaefer of our Office of Conservation and Environmental Affairs staff at 587-0377 if there are any further questions.

Aloha,

MICHAEL D. WILSON

Attachments

xc: Andrew Forbes

END

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MARYANNE W. KUSAKA
XXXXXXXXXXXXXXXXXXX
MAYOR

COUNTY OF KAUAI
PLANNING DEPARTMENT
4444 RICE STREET, SUITE 473
LIHUE, KAUAI, HAWAII 96766

DEE M. CROWELL
PLANNING DIRECTOR

XXXXXXXXXXXXXX
DEPUTY PLANNING DIRECTOR

TELEPHONE (808) 241-6677
FAX (808) 241-6699

January 4, 1995

State of Hawaii
Department of Land and Natural Resources - OCEA
P. O. Box 621
Honolulu, HI 96809

Attention: Roy Schaefer

Subject: Conservation District Use Application KA-2734
Acoustic Thermometry of Ocean Climate (ATOC)
Offshore, North Shore, Kauai

Thank you for the opportunity to comment on the above referenced application. The project will be located in ocean waters makai of the shoreline, and therefore outside of the County of Kauai Special Management Area (SMA). An SMA Permit will not be required.

Although the project will be located outside of the SMA, we are concerned with the potential impacts of the sound transmissions on marine life. It is noted that the Marine Mammal Research Program will evaluate the potential effects of the transmissions on marine mammals and sea turtles. Impacts on other marine life also should be considered. If significant adverse impacts on marine life are noted, mitigation measures should be provided, or the project should be reevaluated.

Please contact George Kalisik of my staff at 241-6677 if you have any questions.

Sincerely,

Dee M. Crowell
Planning Director

c: Andrew Forbes, Scripps Institution of Oceanography

END

RECEIVED
DEC 27 1994

JOHN WAIHEE
GOVERNOR

ROBERT A. MARKS
ATTORNEY GENERAL

RUTH I. TSUJIMURA
FIRST DEPUTY ATTORNEY GENERAL

STATE OF HAWAII
DEPARTMENT OF THE ATTORNEY GENERAL
REGULATORY DIVISION
465 SOUTH KING STREET, ROOM 200
HONOLULU, HAWAII 96813-2913
(808) 587-3050
FAX (808) 587-3077

December 16, 1994

FAX TRANSMISSION

Mary L. Hudson FAX: (510) 465-6248
1736 Franklin Street, Eigthth Floor
Oakland, CA 94612-3419

Dear Ms. Hudson:

Re: ATOC, Acoustic Thermometry of Ocean Climate Project
Water Quality Issues

This confirms points that I made in our phone conversation yesterday. The following position is subject to confirmation by the Hawaii State Department of Health.

The Hawaii State Department of Health (DOH) need not process a section 401 water quality certification application if no federal permit is required or if the federal permit does not allow an activity that causes a discharge to state waters. I understand that the DOH is waiting for a letter from the Corps of Engineers (COE) as to what type(s) of permit(s) the COE will issue, if any, for the ATOC project. Historically, in DOH's experience, COE section 10 permits have not involved discharges and thus have not required DOH water quality certification. DOH reserves its right to examine any activity under any federal permit, including a section 10 permit, to determine if a discharge is involved.

The State reserves its rights to regulate noise that harms marine life in state waters. For now we have no evidence that such harm will occur from the ATOC project, nor do we now take a position on what laws, if any, will apply if there is harm. We note that the director of health has authority to regulate water pollution and noise pollution, HRS §§ 342D-4, 342F-3, and state law prohibits causing water pollutants to enter state waters except as in compliance with statute, rules, a permit or variance, HRS § 342D-50(a), and prohibits activities which produce "excessive noise" without written permission from the director, HRS § 342F-30. I am not aware that DOH has ever tried to regulate noise in state waters. The ATOC project is a very novel proposal that has yet to be implemented, and many specific facts are thus uncertain. Also, you report that if the marine mammal research phase shows any adverse effect on marine life, the sound transmissions will be suspended and operation of the program will be modified to mitigate such adverse effect. You also report that after the marine mammal research phase, a report of the findings will be published, so that interested people can review the matter. Given the uncertainty of facts now and the report of research later, and given the claim that any possible harm would be momentary, we think that it is premature to attempt to provide definite legal answers about whether and how state pollution control laws apply.

Yours truly,

Laurence K. Lau
Deputy Attorney General

c: Denis R. Lau

2785+

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PATSY T. MINK
SECOND DISTRICT, HAWAII

[illegible]

Congress of the United States
House of Representatives
Washington, DC 20515-1102

COMMITTEE ON BUDGET
COMMITTEE ON EDUCATION AND LABOR
[illegible]
COMMITTEE ON NATURAL RESOURCES
COMMITTEE ON GOVERNMENT OPERATIONS

November 30, 1994

Dr. Ralph Alewine
Nuclear Monitoring Res. Ofc.
Advanced Research Projects
Agency
3701 North Fairfax Dr.
Arlington, VA 22203-1714

Dear Dr. Alewine:

RE: Acoustic Thermometry of Ocean Climate

I am writing to strongly protest the covert actions taken by Scripps Institution of Oceanography before it conducted the Acoustic Engineering Test (AET) earlier this month off the California coast -- in the absence of a final EIS for the Acoustic Thermometry of Ocean Climate (ATOC). It is unconscionable that the ATOC experiment was allowed to run, simply under a different name. This is highly objectionable and sets a dangerous precedent for the State of Hawaii -- based on the fact that Scripps has proposed to run an AET off the Kauai coast in early 1995.

I enclose a copy of a letter to you from Sierra Club Legal Defense Fund, written on behalf of 20 environmental organizations in Hawaii. I also enclose a copy of a letter to the State of Hawaii from the Kauai Friends of the Environment, opposing a project to be run by the State which is very similar to ATOC. I ask that you specifically address each argument made in the former, and make close note of the latter.

The California AET was pursued without full public input. The test date was improperly publicized. The EA was not released on time, nor was it widely distributed for comment. Tactics employed by Scripps amount to subversion, which leads me to believe that Scripps will attempt to blatantly mislead concerned citizens in Hawaii before it conducts its proposed AET off the coast of Kauai.

When will the date for the Kauai test be publicized? Will an EA be required? Will public hearings be held?

How is it possible that Scripps is complying with the Marine Mammal Protection Act, Endangered Species Act and National Environmental Policy Act without possessing permits for the AET? The environmental impacts of this experiment have not been fully evaluated. No federal actions are being taken to halt these illegal procedures.

RECEIVED AS FOLLOWS

The ATOC project should not be allowed to proceed in any form or under any other name, especially without thorough evaluation of its impacts on marine mammals and full public disclosure.

Your immediate response to my letter will be deeply appreciated.

Very truly yours,

PATSY T. MINK
Member of Congress

RECEIVED AS FOLLOWS

Office of the Governor
MAILING ADDRESS: P.O. BOX 3540, HONOLULU, HAWAII 96811-3540
STREET ADDRESS: 250 SOUTH HOTEL STREET, 4TH FLOOR
TELEPHONE: (808) 587-2846, 587-2800

Ref. No. C-598

May 10, 1994

Dr. William W. Fox, Jr.
Director
Office of Protected Resources
National Marine Fisheries Service
1335 East-West Highway
Silver Spring, Maryland 20910

Dr. David W. Hyde
Scripps Institution of Oceanography
Institute for Geophysics and Planetary Physics
Acoustic Thermometry of Ocean Climate Program
9500 Gilman Drive
La Jolla, California 92093-0225

Dear Doctors Fox and Hyde:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency for the Acoustic Thermometry of Ocean Climate Program (ATOC), Kauai, Hawaii

This is to inform you that the application by the Scripps Institution of Oceanography for a permit for scientific research under the Marine Mammal Protection Act of 1972 (MMPA), as amended (16 U.S.C. 1361 et seq.) requires CZM Federal consistency approval from the Office of State Planning. The Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.) and its implementing regulations (15 C.F.R. Part 930, Subpart D) require applicants for Federal licenses or permits in or outside of the coastal zone, affecting any land or water use or natural resource of the coastal zone of that state to provide a certification that the proposed activity complies with the enforceable policies of the state's Federally approved CZM program and shall be conducted in a manner consistent with the CZM program.

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In accordance with the Federal consistency regulations (15 C.F.R. 930.53), Hawaii's CZM program identifies specific Federal licenses and permits, including those required by the MMPA, which must be approved for CZM consistency. The Office of State Planning has not yet received a CZM consistency certification for the ATOC program in Hawaii. The CZM consistency certification should be submitted as soon as possible because the MMPA permit may not be issued without our concurrence (15 C.F.R. 930.53(e)).

Hawaii's CZM consistency requirements include those prescribed in 15 C.F.R. 930, Subpart D, and an assessment of the activity in relation to the objectives and policies of Hawaii's CZM Program. Enclosed is a copy of our CZM Federal consistency guide which contains a CZM assessment form and consistency certification form. The EIS under preparation should also be submitted as supplemental information.

Thank you for your cooperation in complying with Hawaii's CZM Program. If you need help or have any questions, please call our CZM office at (808) 587-2878.

Sincerely,

Harold S. Masumoto
Director

Enclosure

bc: U.S. National Marine Fisheries Service, Pacific Area Office
Office of Ocean and Coastal Resource Management, NOAA
U.S. Army Corps of Engineers, Operations Division
Department of Health, Clean Water Branch
Department of Land & Natural Resources, OCEA
Department of Transportation, Harbors
Planning Department, County of Kauai

JDN/hc
JDN/##

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5411

WAIHEE
GOVERNOR

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'94 OCT 28 PM 12:32

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

DLNR
OCEA

REX D. JOHNSON
DIRECTOR

DEPUTY DIRECTORS
KANANI HOLT
GLENN M. OKIMOTO
JOYCE T. OMINE
CALVIN M. TSUDA

IN REPLY REFER TO:

PMN 7.4343

October 25, 1994

TO: The Honorable Keith W. Ahue, Chairperson
Board of Land and Natural Resources

FROM: Rex D. Johnson
Director of Transportation

SUBJECT: Request for Comments - Conservation District Use Application KA-2734 - Acoustic Thermometry of Ocean Climate

Thank you for requesting our comments on the subject CDUA.

The project does not appear to have any discernible impact on our commercial harbor facilities or operations.

RECEIVED
'94 OCT 28 A9:36
DEPT. OF LAND
& NATURAL RESOURCES
STATE OF HAWAII

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED
'94 OCT 21 AM 10:52
DLNR
OCEA

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JOHN P. KEPPELER II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

October 18, 1994

MEMORANDUM

LOG NO: 12880
DOC NO: 9410NM02

TO: Roger Evans, Acting Administrator
OCEA

FROM: Don Hibbard, Administrator
State Historic Preservation Division

SUBJECT: **CDUA KA-2734 Accoustic Termometry of Ocean Climate (Scripps Institution of Oceanography), Pacific Missle Range Facility Mana, Waimea, Kauai**

No field check is required, as we believe that the project will have a "no effect" on significant historic sites as it is offshore where it is unlikely that significant historic sites are located..

If you have any questions, please call Nancy McMahon at 587-0006.

NM:jk

DEPARTMENT OF WATER
COUNTY OF KAUAI
P.O. BOX 1706
LIHUE, HAWAII 96766-5706
PHONE NO: (808) 245-6986 FAX NO. 245-5813

Rec'd CCEA, 10/20/94

RECEIVED
94 OCT 20 A8:41
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

October 14, 1994

Honorable Keith W. Ahue
Department of Land
and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Re: Conservation District Use Application No. KA-2734 - Proposed to Temporarily Place a Subsea Cable and a Sound Source on Submerged Land off the North and Northwest Coast of Kauai, for Research Experiment for Measuring Global Ocean Climate Variability by the Use of Acoustic Signals in the Deep Sound Channel, Kauai, Hawaii

We have no objections to this Conservation District Use Application.

If there are any questions, please call Edward Doi at 245-6986.

10/17/94
Murl T. Nielsen
Manager & Chief Engineer

ED:et

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808 934 7979 P.02

RECEIVED '94 OCT 25 PM 2:33 DLNR OCEA

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
File: EMD/CWB

October 13, 1994

C1004EC

RECEIVED 94 OCT 24 A 9:06 DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

Mr. Andrew Forbes
Institute of Geophysics and
Planetary Physics, 0225
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive
La Jolla, California 92093-0225 USA

Dear Mr. Forbes:

Reference is made to your August 29, 1994 letter to Lieutenant Colonel Bruce Elliott of the U.S. Army Corps of Engineers (COE), Honolulu District, regarding the permitting requirements for the Acoustic Thermometry of Ocean Climate (ATOC) Facilities Project, Cable Installation off the northshore of Kauai.

The Department does not concur with your conclusion with regards to the requirements for a Section 401 Water Quality Certification (WQC). Please be informed that Section 401(a) of the Clean Water Act (CWA) requires "any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate ... ."

A Department of the Army (DA) permit issued under Section 404 of the CWA authorizes the discharge of dredged or fill material into navigable waters at specific disposal site (emphasis added). A Section 401 WQC or a waiver is required for all activities that require a DA Section 404 permit. Enclosed for your use is one (1) copy each of the Section 401 WQC application form and guidelines.

In addition, Section 342D-1 of the Hawaii Revised Statutes defines "Water Pollution" as:

"(1) Such contamination or other alteration of the physical, chemical, or biological properties of any state waters, including change in temperature, taste, color, turbidity, or odor of the waters, or

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(2) Such discharge of any liquid, gaseous, solid, radioactive, or other substances into any state waters,

as will or is likely to create a nuisance or render such waters unreasonably harmful, detrimental, or injurious to public health, safety, or welfare, including harm, detriment, or injury to public water supplies, fish and aquatic life and wildlife, recreational purpose and agricultural and industrial research and scientific uses of such waters or as will or is likely to violate any water quality standards, effluent standards, treatment and pretreatment standards, or standards of performance for new sources adopted by the department." (emphasis added)

There was insufficient information contained in your August 29, 1994 letter to properly justify that both the construction and operation related activities of the project will not result in any "water pollution" in State waters. Additional information is required to adequately address this issue. The Department intends to evaluate the potential project related impact to the State waters through the processing of a Section 401 WQC application.

In conclusion, the Department recommends that you submit a complete Section 401 WQC application package which includes the Final Environmental Impact Statement (FEIS) for further evaluation.

Should you have any questions, please contact Mr. Edward Chen, Engineering Section of the Clean Water Branch, at (808) 586-4309.

Sincerely,

for DENIS R. LAU, P.E., CHIEF
Clean Water Branch

EC:sa

Enclosures: Section 401 WQC Application Form and Guidelines

c: U.S. Army COE, Operations Division (w/o encls.)
NOAA, National Marine Fisheries Service (w/o encls.)
Environmental Protection Agency, Region 9 (w/o encls.)
State Department of Land and Natural Resources (w/o encls.)

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DEPT. OF LAND & NATURAL RESOURCES

OFFICE OF CONSERVATION & ENVIRONMENTAL AFFAIRS

NOTICE OF MESSAGE RECEIVED

DATE 10-13-94 TIME 12:00 A.M. P.M.

FOR Roy

FROM Claude Sutcliffe (MR.) (MRS.) (MISS) (MS.)

OF

PHONE 553-3844 EXT.

- [x] TELEPHONED
- [ ] CAME TO SEE YOU
- [ ] RETURNED YOUR CALL
- [ ] LEFT THE FOLLOWING MESSAGE:
- [x] PLEASE CALL
- [ ] WILL CALL AGAIN
- [ ] WANTS TO SEE YOU
- [ ] URGENT - CALL AT ONCE

Re: EIS for ATOC on Kauaʻi wants a copy

TAKEN BY: Rebecca

DEPT. OF LAND & NATURAL RESOURCES

OFFICE OF CONSERVATION & ENVIRONMENTAL AFFAIRS

NOTICE OF MESSAGE RECEIVED

DATE 10/10/94 TIME 12:10 A.M. (P.M.)

FOR Roy

FROM Sarah Sykes (MR.) (MRS.) (MISS) (MS.)

OF P.O. Box 270 Kaunakakai 96748

PHONE EXT.

- [x] TELEPHONED
- [ ] CAME TO SEE YOU
- [ ] RETURNED YOUR CALL
- [x] LEFT THE FOLLOWING MESSAGE:
- [ ] PLEASE CALL
- [ ] WILL CALL AGAIN
- [ ] WANTS TO SEE YOU
- [ ] URGENT - CALL AT ONCE

Send copy of EIS for ATOC project.

TAKEN BY: Rico

RECEIVED AS FOLLOWS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

OCT 3 1994

In reply, please refer
to: FILE NO.: KA-2734
Acceptance Date: 9/28/94
180-Day Exp. Date: 3/27/95
SUSPENSE DATE: 21 Days
DOC. ID.: 4968

'94 OCT -5 P2:25 RECEIVED
FORESTRY & WILDLIFE STATE OF HAWAII

R3

MEMORANDUM

TO: Aquatic Resources, Conservation & Resources Enforcement, Forestry & Wildlife, Land Management, State Parks, Historic Preservation, Water Commission, Water and Land Development, Boating and Ocean Recreation, Natural Area Reserves System

FROM: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

SUBJECT: REQUEST FOR COMMENTS (Previously Circulated to All Divisions)
Conservation District Use Application

APPLICANT: Scripps Institution of Oceanography
University of California San Diego

FILE NO.: KA-2734

REQUEST: Acoustic Thermometry of Ocean Climate (ATOC) - Installation of Equipment on the Ocean Floor

LOCATION: 8 Miles Offshore - North and Northwestern Side of Kauai

TMK(s): Offshore Kauai

'94 OCT 14 PM 1:43 RECEIVED DLNR OCEA

PUBLIC HEARING: YES X NO ____

DOCARE: Please conduct a field inspection on this project. Should you require additional information, please call Roy Schaefer at 7-0383.

If no response is received by the suspense date, we will assume there are no comments.

ROGER C. EVANS

October 14, 1994
DOFAW HAS NO COMMENTS OR OBJECTIONS TO THE PROPOSED REQUEST.

Administrator
MICHAEL G. BUCK

Attachment(s)

cc: Kauai District

RECEIVED AS FOLLOWS

RECEIVED DIVISION OF STATE PARKS
OCT 5 8 42 AM '94

TO:
___ ADMINISTRATOR
___ ASST. ADMIN.
___ DEV. BR.
___ PLAN BR.
___ RES. MGT. BR.
___ PROJ. CONTROL
___ SW. REC. PLAN.
___ CLERICAL STAFF
___ ADMIN. ASST.
___ INTERP. BR.

FOR:
___ CIRCULATE/POST/STAFF RM
___ COMMENTS & REC.
___ DRAFT REPLY
___ FILE
___ FOLLOW UP
___ INFO.
___ RUSH (DUE ___)
___ SEE ME
___ SEND COPY TO: ___

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

OCT 3 1994

In reply, please refer
to: FILE NO.: KA-2734
Acceptance Date: 9/28/94
180-Day Exp. Date: 3/27/95
SUSPENSE DATE: 21 days
DOC. ID.: 4968

MEMORANDUM

~~TO:~~ From: Aquatic Resources, Conservation & Resources Enforcement, Forestry & Wildlife, Land Management, State Parks, Historic Preservation, Water Commission, Water and Land Development, Boating and Ocean Recreation, Natural Area Reserves System

~~FROM:~~ To: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

SUBJECT: REQUEST FOR COMMENTS (Previously Circulated to All Divisions)
Conservation District Use Application

APPLICANT: Scripps Institution of Oceanography
University of California San Diego

FILE NO.: KA-2734

REQUEST: Acoustic Thermometry of Ocean Climate (ATOC) - Installation of Equipment on the Ocean Floor

LOCATION: 8 Miles Offshore - North and Northwestern Side of Kauai

TMK(s): Offshore Kauai

'94 OCT 6 PM 3:03 RECEIVED DLNR OCEA

PUBLIC HEARING: YES X NO ___

DOCARE: Please conduct a field inspection on this project. Should you require additional information, please call Roy Schaefer at 7-0383.

If no response is received by the suspense date, we will assume there are no comments.

ROGER C. EVANS

Attachment(s)

No comments.

RALSTON NAGATA, State Parks
Administrator
Date: 10/6/94

1007

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

OCT 3 1994

In reply, please refer to: FILE NO.: KA-2734
Acceptance Date: 9/28/94
180-Day Exp. Date: 3/27/95
SUSPENSE DATE: 21 days
DOC. ID.: 4968

MEMORANDUM

TO: Aquatic Resources, Conservation & Resources Enforcement, Forestry & Wildlife, Land Management, State Parks, Historic Preservation, Water Commission, Water and Land Development, Boating and Ocean Recreation, Natural Area Reserves System

FROM: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

SUBJECT: REQUEST FOR COMMENTS (Previously Circulated to All Divisions)
Conservation District Use Application

APPLICANT: Scripps Institution of Oceanography
University of California San Diego

RECEIVED
OCT 5 1994
Div. of Aquatic Resources

FILE NO.: KA-2734

REQUEST: Acoustic Thermometry of Ocean Climate (ATOC) - Installation of Equipment on the Ocean Floor

LOCATION: 8 Miles Offshore - North and Northwestern Side of Kauai

TMK(s): Offshore Kauai

PUBLIC HEARING: YES X NO ____

DOCARE: Please conduct a field inspection on this project. Should you require additional information, please call Roy Schaefer at 7-0383.

If no response is received by the suspense date, we will assume there are no comments.

ROGER C. EVANS

Attachment(s)

RECEIVED '94 OCT 20 AM 9:45 DLNR OCEA

See attached
Henry M. Sakuda

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

OCT 3 1994

In reply, please refer
FILE NO.: KA-2734
Acceptance Date: 9/28/94
180-Day Exp. Date: 3/27/95
SUSPENSE DATE: 21 days
DOC. ID.: 4968

MEMORANDUM

TO: Aquatic Resources, Conservation & Resources Enforcement, Forestry & Wildlife, Land Management, State Parks, Historic Preservation, Water Commission, Water and Land Development, Boating and Ocean Recreation, Natural Area Reserves System

FROM: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs

SUBJECT: REQUEST FOR COMMENTS (Previously Circulated to All Divisions)
Conservation District Use Application

APPLICANT: Scripps Institution of Oceanography
University of California San Diego

FILE NO.: KA-2734

REQUEST: Acoustic Thermometry of Ocean Climate (ATOC) - Installation of Equipment on the Ocean Floor

LOCATION: 8 Miles Offshore - North and Northwestern Side of Kauai

TMK(s): Offshore Kauai

PUBLIC HEARING: YES X NO ____

DOCARE: Please conduct a field inspection on this project. Should you require additional information, please call Roy Schaefer at 7-0383.

If no response is received by the suspense date, we will assume there are no comments.

ROGER C. EVANS

DOWALD has no comments

MANABU TAGOMORI

Attachment(s)

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DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

OCT 3 1994

DOC. NO.: 4976

MEMORANDUM

TO: KEITH W. AHUE, Chairperson

FROM: ROGER C. EVANS, Administrator
Office of Conservation and Environmental Affairs

SUBJECT: Request to hold a public hearing for Conservation District Use Applications:

CDUA	APPLICANT	LOCATION	RATIONALE	180-DAY EXP.DATE
KA-2734	Scripps Institution of Oceanography, University of California San Diego	Submerged Lands Offshore of north and northwestern side of Kauai	High Public Interest	3/27/95

RECOMMENDATION:

Pursuant to Section 183-41, HRS, as amended, and Administrative Rules, Title 13, Chapter 2, as amended; and as authorized by the Board of Land and Natural Resources on November 2, 1984; it is recommended that the Chairperson:

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Re: Conservation District Use Application No. KA-2734

Further, there is considerable fishing activity in this area. Kauai fishermen caught 37,590 pounds of fish in Fisheries Statistical Area No. 523 during calendar year 1993, which encompasses the area where the transducer will be deployed. About 34,425 pounds were caught by trollers and 2,768 pounds by bottomfishermen, so much of the activity is off-shore.

Finally, the hypothesis that sound can be used to obtain average ocean temperatures seems reasonable, but the need for this particular approach is not explained in the CDUA. For example, ocean thermal data are currently collected by merchant shipping using XBT (expendable bathythermograph) recorders, USN, USCG, and NOS ships, NOAA data buoys, satellite imaging, and other research and commercial vessels. The applicant should clarify why existing ocean thermal data collection measures need to be supplemented by the ATOC project.

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DEPARTMENT OF LAND AND NATURAL RESOURCES
Office of Conservation and Environmental Affairs
Honolulu, Hawaii

AUG 26 9 55 AM '94

RS

FILE NO.: KA-2734
SUSPENSE DATE: Three weeks
DOC. ID.: 4834

AUG 25 1994

MEMORANDUM

TO: Aquatic Resources; Conservation & Resources Enforcement; Forestry & Wildlife; Historic Preservation Division; Land Management; Natural Area Reserves System; State Parks; Water and Land Development; Commission on Water Resource Management; Boating and Ocean Recreation

FROM: Office of Conservation and Environmental Affairs

SUBJECT: Application for Proposed Use of State-Owned Conservation District Lands, Review for Chairperson's Signature

Attached is a copy of an application submitted by Scripps Institution of Oceanography for the Acoustic Thermometry of Ocean Climate (ATOC) project on submerged land identified as offshore of Kauai, off the north and northwestern side of Kauai.

Board action following the approval of Title 13, Chapter 2, Administrative Rules, as amended, approved on June 22, 1981, requires all applications involving the use of State-owned lands to be signed by the Chairperson on behalf of the Board of Land and Natural Resources as landowner. Exceptions to this procedure may occur where the applicant provides evidence indicating a legal interest in the property or proposed site of use in accordance with Section 2 of Chapter 183-41, HRS, as amended.

Consequently, your comments and recommendations on the application with respect to present and future programs for which you are responsible will be forwarded to the Chairperson to consider before signing the application. It should be noted that the Chairperson's signature on the application is only to comply with CDUA procedures and does not mean the endorsement of the proposed use.

Your cooperation and early response, with the return of all attachments, will be appreciated. Should you have any questions, feel free to contact Roy Schaefer of my staff at 7-0377.

If no response is received by the suspense date, we will assume there are no comments.

ROGER C. EVANS

Attachments

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'94 OCT 10 PM 2:51
DLNR
OCEA

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1. Authorize public hearings for the proposed use; and

2. Authorize preparing and forwarding the hearing notice to the applicant and other affected persons.

Under the authority delegated by the Board of Land and Natural Resources at its meeting of November 2, 1984, this request for public hearing as described herein is hereby:

(✓) APPROVED
( ) DISAPPROVED

Dated at Honolulu, Hawaii this

6th day of October, 1994.

STATE OF HAWAII

By: [signature]
KEITH W. AHUE, Chairperson and Member
Board of Land and Natural Resources

RECEIVED AS FOLLOWS

State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

Date: September 6, 1994

: Paul Kawamoto, Aquatic Biology Program Manager
RU: RS Richard Sixberry, Aquatic Biologist
OM: Walter Ikehara, Aquatic Biologist
IBJECT: Comments on Conservation District Use Application KA-2734

omment equested by: Roger Evans, Office of Conservation and Environmental Affairs | Date of Request 08/25/94 | Date Rec'd. 08/25/94

ummary of Proposed Project

Title: Acoustic Thermometry of Ocean Climate (ATOC) Project

Project by: Scripps Institute of Oceanography, UCSD, La Jolla, CA

Location: Submerged Lands North of Kauai

Brief Description:

The Scripps Institute of Oceanography (SIO) proposes to carry out a project that uses sound to indirectly measure the temperature of the north Pacific ocean. This involves the laying of an undersea cable (already done) and the installation of a high-power, low-frequency transducer north of Hanalei Bay, Kauai in 829 meters depth. Another transducer will be emplaced off California. Receivers will be in many sites around the north Pacific.

In response to previous concerns about the effects of the sound pulses produced by the transducer, SIO proposes to monitor marine mammal and sea turtle behavior for a period of six months before proceeding with the full 18 month project.

Comments:

In general, the DAR supports research leading to greater knowledge of the ocean and its marine life. However, we do not condome after-the-fact approvals for the laying of the cable in October, 1993, without approval.

The proposed site of the transducer is 22° 21.003'N, 159° 34.161'W, about 8 miles north of Hanalei Bay in 829 meters depth. We recently placed a Fish Aggregating Device (FAD) "EK" at 22° 18.0'N, 159° 26.2'W in about 1,650 meters depth about 8.5 miles ESE from the proposed transducer site. Although the sites are separated enough to preclude interference between the FAD anchors and the cable, it is not known if the sound pulses may affect the behavior of fish around the FAD. As in the case of marine mammals, little is known about the effect of high-power, low-frequency sound on fish. The proposed MMRP study may yield data on the effects of sound on marine mammals and turtles. In addition, we suggest that opportunity is available for monitoring and investigating the effects of artificially produced sound on other marine life as well.

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INFORMATION

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

APR 12 1994

Dr. Christopher Clark
Director, ATOC Marine Mammal Research Program
Cornell Bioacoustics Research Program
Cornell Laboratory of Ornithology
159 Sapsucker Woods Road
Ithaca, NY 14850

Dear Dr. Clark,

This is in regard to the permit applications (P557 and P557A) and subsequent modifications requested by the Scripps Institution of Oceanography's (SIO) Acoustic Thermometry of Ocean Climate Project (ATOC) which added five listed sea turtle species for scientific research under the Endangered Species Act (ESA).

We are concerned that ATOC transmissions may adversely affect sea turtle populations in Kauai and Point Sur. During the public comment period, it was brought to our attention that some sea turtles are sensitive to low frequency sounds from 25 to 750 Hz. Loggerhead sea turtles (Caretta caretta) exhibit a startle response to very low frequency sounds, with intensity in excess of 175 dB.

There are significant sea turtle populations in the waters near Kauai and Point Sur, the proposed locations for the ATOC source transmissions. These regions provide important foraging areas for resident sea turtles and serve as migratory corridors for sea turtles travelling between their feeding and breeding areas. There are also some sea turtle nesting locations on Kauai. We are concerned about all listed species that occur in these areas, recognizing that you are most likely to encounter green (Chelonia mydas) and leatherback (Dermochelys coriacea) sea turtles off Kauai and leatherbacks off Point Sur.

The sea turtle research proposed in the permit applications includes monitoring sea turtles during aerial observations and surveys for marine mammals. Visual observations (aerial/vessel/land) alone may not be sufficient to monitor the behavior of sea turtles. Such observations can be used to estimate distribution and abundance.

We strongly recommend that you develop a more comprehensive research program to determine the behavioral and physiological effects of the ATOC project on sea turtles. The ATOC group has assembled a well qualified team of marine mammal experts. We recommend a similar team of sea turtle

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experts be assembled to advise the ATOC project and develop an adequate research program to determine the effects of the ATOC source transmissions on listed sea turtles. A NOAA/NMFS Pacific Basin Sea Turtle Recovery Team is already assembled and may be able to provide advise to the ATOC project. Dr. Scott Eckert, Recovery Team Coordinator, may be contacted at (619) 226-3872.

Please contact Carol Fairfield of my staff if you have any questions.

Sincerely,

Ann Terbush, Chief
Permits Division
Office of Protected Resources

cc: Ralph Alowine
George Balazs
Scott Eckert
Carol Fairfield
Andrew Forbes
David Hyde
Walter Munk
Clayton Spikes
Phil Williams

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SENT BY: ; 11-14-94 ; 8:14AM ; DLNR / OCEA→ 808 554 7579;#11
808 934 7979 P.06

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JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF LAND MANAGEMENT
3060 Eiwa Street, Rm. #304
Lihue, HI 96766-1875

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

October 21, 1994

KD-94:1318

MEMORANDUM

To: Roger Evans
Attention: Roy Schaefer

From: Sam Lee

Subject: File No. KA-2734, ATOC Installation of Equipment on Ocean Floor, Northwest Kauai

As requested by DLNR-DLM pink slip dated October 13, 1994, we have reviewed the application submitted by Scripps Institution of Oceanograph regarding the above matter.

Inasmuch as the proposal does not affect present or future Land Management programs on Kauai, we have no objections to the project.

cc: Mason Young
Herbert Apaka, Jr.
ML:ml

Scoping Comments
(Incoming)

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→ ED/file

SIERRA CLUB LEGAL
DEFENSE FUND, INC.

The Law Firm for the Environmental Movement

223 South King Street, 4th Fl., Honolulu, HI 96813 (808) 599-2436 Fax (808) 521-6841

November 7, 1994

Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809
Attention: Roy Schaefer

RE: Kauai Offshore Acoustic Thermometry of Ocean Climate Project

Dear Mr. Schaefer:

I am writing in response to the EIS preparation notice, published pursuant to the Hawaii Environmental Policy Act ("HEPA") in the OEQC bulletin of October 8, regarding the Acoustic Thermometry of Ocean Climate ("ATOC") project proposed for the coast of Kauai. We provide these comments on behalf of the following 20 organizations: Save Our Shores, The Fund for Animals, Great Whales Foundation, Greenpeace, In Defense of Animals, Earth Island, Friends of the Sea Otter, Surfrider Foundation, Surfers' Environmental Alliance, Coastal Advocates, People for the Ethical Treatment of Animals, Hawai'i's Thousand Friends, Life of the Land, Sierra Club -- Hawai'i Chapter, Animal Rights Hawai'i, Hawai'i Audubon Society, Citizens Against Noise, Save Our Surf, Kaua'i Friends of the Environment, and the Hawai'i Fishermen's Foundation.

We have previously submitted detailed comments (dated April 14, April 29, May 6, May 14 and November 4, 1994) to the National Marine Fisheries Service ("NMFS") and the Advanced Research Projects Agency ("ARPA") regarding the scope of the EISs being prepared pursuant to the National Environmental Policy Act ("NEPA"), the Scientific Research Permit ("SRP") Applications that have been submitted to NMFS by Scripps Institute of Oceanography for the Kaua'i and California ATOC projects, and other aspects of the program. The issues relevant to the scope of the EIS being prepared for the Kaua'i project pursuant to HEPA are substantially similar to those we raised in our prior comments. Consequently, we are attaching copies of our prior comments to this letter, and hereby request that they be considered as scoping comments for the EIS under preparation pursuant to HEPA.

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In our previous comments we detailed at length the need for NMFS and ARPA to prepare a comprehensive, programmatic environmental review that evaluates the cumulative impacts of the ATOC proposal, prior to any elements being implemented. Recent events -- including "playback" studies planned off Kauai, and an Acoustic Engineering Test scheduled to occur over the next two weeks off Baja California -- have heightened the need for such a review.

On October 14, 1994 we became aware of "playback" studies, funded and coordinated by ATOC, that are planned for the waters off Kaua'i this winter. These studies involve the use of a mobile (boat based) transmitter, broadcasting a tape recording of the 70hz ATOC signal at 170 dB. The researchers propose to use the boat, in conjunction with shore-based observers and existing hydrophone arrays, to track whale pods (consisting of one or more individuals) for periods of 1 to 2 hours. Playback trials will be conducted by positioning the boat in front of the pod, deploying the transducer, and broadcasting the recorded ATOC signal, for periods of 15 minutes. Visible responses to the signal are proposed to be noted by shore and boat based observers, and acoustic responses recorded via the hydrophone array.

A request for modifications and an extension to an SRP (Permit No. 813) previously issued for this research were submitted to NMFS on July 25, 1994; neither has been granted to date. According to the SRP application, the work is a component of the ATOC research proposal submitted by Scripps to the Defense Advanced Research Projects Agency (now ARPA). The previous permit conditions allowed for up to 1000 takes of humpback whales by harassment. Harassment is considered to be:

> the disruption by any act or omission of the behavior or activity exhibited by a whale immediately prior to the act or omission. A disturbance or disruption of normal behavior shall be considered to be any of the activities listed in 50 C.R.F. 222.31(a)(4): a rapid change in direction or speed; escape tactics such as prolonged diving, underwater course changes, underwater exhalation or evasive swimming patterns; interruptions of breeding, nursing, or resting activities; attempts by a whale to shield a calf from a vessel or human observer by tail swishing or by other protective movements; or the abandonment of a previously frequented area.

SRP No. 813 at 2.

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Common sense tells us that the playback studies and the associated 1000 takes of humpback whales (as well as a requested 100 takes of sperms whales, and an indefinite number of takes of other species of marine mammals) are justifiable only if ATOC is the best possible method of measuring global ocean temperature. Logically, such a determination can be made only after alternatives to ATOC have been considered. A consideration of alternatives is required by the Marine Mammal Protection Act ("MMPA"): regulations adopted pursuant to the MMPA (see 50 C.F.R. § 216.31(a)(10)), require a detailed justification of the need for taking of animals listed as endangered, including a discussion of possible alternatives. Consideration of alternatives is also required by NEPA (as we have detailed previously) as well as HEPA (H.R.S. § 11-200-17). To date, however, no consideration of alternatives has been undertaken, and no determination made regarding the relative benefits of ATOC in comparison to other research programs on global ocean temperature.

Similarly, it is clear that the playback studies will be of benefit to marine mammals only if the ATOC program is actually modified in accordance with the results of the playback studies. To date, however, no commitment has been made that the ATOC program will be modified or aborted in response to results of the playback studies: the SRP for the playback studies states (at 3) "if low frequency sound is found to alter the behavior of whales, then the design of the LFS-ATOC experiment could then be modified to take these effects into account." (Emphasis added). Playback studies can therefore not be justified at present.

We have outlined the need for a programmatic EIS in our prior comments; the proposed playback studies and AET have made the need for a programmatic EIS even more compelling. The scope of the EIS currently under preparation must address the entire ATOC program. Failure to prepare such a comprehensive review will at a minimum constitute a violation of NEPA and HEPA. Failure to prepare a programmatic EIS prior to initiation of any playback studies will additionally constitute violations of the MMPA and Endangered Species Act.

I appreciate your careful consideration of the concerns that we and others have raised regarding these projects.

Very truly yours,

Mark Smaalders
Resource Analyst
Mid-Pacific Office

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cc: Office of Environmental Quality Control

(without attachments):
Dr. William W. Fox, Jr., NMFS
Dr. Ralph W. Alewine, ARPA
Andrew Forbes, Scripps Institute of Oceanography
Hawaii and California Coalition on ATOC

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11/27/94 14:00 1-- MOLOKAI DISPATCH PAGE 01

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Center for World Peace

HC 01, Box 830, Kalua'aha, Moloka'i, Hawaii 96748 558-8923

'94 NOV 30 AM 11 38

Roy Schaefer
DLNR
PO Box 621
Honolulu 96809

DLNR
OCEA

Dear Mr. Schaefer: November 7, 1994

I am writing to ask that DLNR refuse to grant Conservation District Use Application #KA-2734, and to propose that the EIS for the ATOC Project should be global in scope, since it may ultimately threaten life -not just "marine" life, but possibly human life, as well- in all the world's oceans.

I am particularly concerned about the possible effect of the ATOC Project on Hawaii's humpback whales, which are supposed to be protected by law, as I indicated in my testimony to the National Marine Fisheries Service (a copy of which I have enclosed, and ask to be put on record).

It bothers me greatly that CDUA #KA-2734 does not include the required Management Plan for the Marine Mammal Research Project, which is the heart of the application, particularly since Scripps is honest enough to admit that "the proposed cable ... was prematurely laid in October 1993." Who let that happen? What has happened to them? And since Scripps admits that they jumped the gun, why have they not been found in violation of the law and fined?

Basically, I am asking that DLNR do its job and protect our environment. Please deny the Conservation District Use Application. Please enforce the law, and prosecute offenders who break the law. Please ask for a EIS that is global in scope, and that includes possible affects on humans.

Thank you very much for your time and attention.

Malama Pono!

[signature]

Claud Sutcliffe, PhD.

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Sunrise, Mt McKinley   Ansel Adams

SIERRA CLUB LEGAL DEFENSE FUND, INC.

The Law Firm for the Environmental Movement

223 South King Street, 4th Fl., Honolulu, HI 96813 (808) 599-2436 FAX (808) 521-6841

November 4, 1994

Via Facsimile Transmission

Dr. Ralph W. Alewine, III
Director, Advanced Research Projects Agency
Nuclear Monitoring Research Office
3701 North Fairfax Drive
Arlington, VA 22203

Dr. William W. Fox, Jr.
Director, Office of Protected Resources
National Marine Fisheries Service
1335 East-West Highway, Room 13130
Silver Spring, MD 20910

Dr. Walter Munk
Scripps Institution of Oceanography
221 IGPP Building/Mail Code 0225
9500 Gillman Drive
La Jolla, CA 92093

Re: ATOC Acoustic Engineering Test

Gentlemen:

We write on behalf of a coalition of the following 20 organizations: Save Our Shores, Natural Resources Defense Council, The Fund for Animals, Great Whales Foundation, Greenpeace, In Defense of Animals, Earth Island Institute, Friends of the Sea Otter, Surfrider Foundation, Surfers' Environmental Alliance, People for the Ethical Treatment of Animals, Hawai'i's Thousand Friends, Life of the Land, Sierra Club - Hawai'i Chapter, Animal Rights Hawai'i, Hawai'i Audubon Society, Citizens Against Noise, Save Our Surf, Kaua'i Friends of the Environment, and the Hawai'i Fishermen's Foundation.

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We are greatly disturbed by, and vigorously protest, the manner in which Scripps Institution of Oceanography ("Scripps") and Advanced Research Projects Agency ("ARPA") have chosen to proceed with the acoustic engineering test ("AET") of the ATOC sound source off the California coast, and National Marine Fisheries Services' ("NMFS'") disregard of its legal obligations. Scripps' and ARPA's insistence upon carrying out the AET in the absence of an EIS for the ATOC program, concealment of the intended date of commencement of the test until approximately two weeks beforehand, failure to distribute any protocol or environmental assessment until one week in advance of the test date, and failure to allow for any public comment on the belated EA all demonstrate clearly Scripps' and ARPA's aversion to public access and input. It is equally clear that Scripps and ARPA are intent upon continuing their consistent pattern of seeking to avoid compliance with federal law that mandates such access and input, as well as meaningful analysis of environmental impacts and alternatives to their proposed experiments. By lending its imprimatur to these activities, NMFS is disregarding its obligation under the Marine Mammal Protection Act ("MMPA") and Endangered Species Act ("ESA") to ensure that marine mammals are protected, and to comply with the National Environmental Policy Act ("NEPA").

As we have described in our scientific research permit application and EIS scoping comments dated April 14, May 6, and May 14, 1994, NEPA requires NMFS and ARPA to prepare a comprehensive programmatic EIS that evaluates the cumulative impacts of the ATOC program <u>before</u> any significant aspect of the program is implemented, and before resources are irrevocably committed. This obligation cannot be avoided merely by arbitrarily breaking out various portions of the program into convenient units or phases and then analyzing (or failing to analyze) them in isolation. AET, as an interdependent part of the larger ATOC program that depends for its justification on that program as a whole, is a "connected action" within the meaning of 40 C.F.R. § 1508.25(a)(1)(iii). The AET also will have cumulative impacts when viewed with the other parts of the ATOC program, as described in 40 C.F.R. § 1508.25(a)(2). The impacts of the entire ATOC program therefore must be fully considered, and alternatives to that program fully explored, in a programmatic EIS, and that EIS must be subjected to the required review and comment process, before an AET is conducted. NMFS and ARPA are required to take affirmative steps to insure compliance with this process, such as seeking injunctive relief or sanctions. 40 C.F.R. § 1506.1; Memorandum: Questions and Answers About the NEPA Regulations, 46 Fed.Reg. 18026 (Mar. 23, 1981), as amended, 51 Fed.Reg. 15618 (Apr. 25, 1986)("Forty Questions"), Question 11. Instead, they are aiding and abetting the law's disregard.

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Even if it were appropriate to pretend that the AET is a stand-alone project that is not being undertaken to implement the larger ATOC program, and therefore to consider the impacts of the AET in isolation, the last-minute notice of the test and exclusion of public input are wholly improper. Scripps states in its October 24 press release that the AET was discussed as early as July 19, 1994, as though the public was given four months' notice of the test. Neither a date for the test nor a protocol were provided at that time, however. It appears that neither Scripps nor ARPA nor NMFS had any intention of notifying the public that the AET was actually going to be conducted, starting on November 9, until after we discovered that playback studies near Kaua'i were being planned, and Scripps was persuaded that further concealment of those plans from the public was ill-advised. Only then did Scripps issue the October 24 release, disclosing the AET plans together with the playback studies. The fact that the AET was discussed in general terms in July thus shows, not that the public has been kept adequately informed, but rather that Scripps, NMFS, and ARPA have had months to make known their specific plans, yet chose not to do so until the eleventh hour; even then, it is questionable whether this disclosure was entirely voluntary.

Scripps', ARPA's, and NMFS' approach to the environmental assessment of the AET similarly demonstrates a refusal to subject their actions to public scrutiny, as though only those with vested interests in seeing ATOC proceed are qualified to comment on any aspect of the program, or are even entitled to know about it. The AET has been planned for months, and the commencement date was selected weeks, if not months ago, yet the EA - revealing for the first time not only the AET's potential environmental impacts, but also the manner in which the test will actually be conducted - is being made available to the public less than one week before the test (and even then only with difficulty; it took several days of telephone calls to pry the EA loose.) The timing of the EA's release in relation to the test obviously indicates ARPA's intent to thwart public participation and comment on the EA, in violation of law. Therefore, on behalf of our clients, we hereby request a public hearing and a 30-day comment period before the AET is scheduled to proceed.

Failure to allow for public involvement in, or comment on, the EA violates both the CEQ's NEPA regulations and the Department of Defense's own NEPA regulations. The former provide:

> Agencies <u>shall</u>:
> (a) Make diligent efforts to involve the public in preparing and implementing their NEPA procedures.
>
> * * *

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> (c) Hold or sponsor public hearings or public meetings whenever appropriate or in accordance with statutory requirements applicable to the agency. Criteria shall include whether there is:
>
> (1) Substantial environmental controversy concerning the proposed action or substantial interest in holding the hearing.

40 C.F.R. S 1506.6 (emphasis added). Section 1501.4(e)(2) provides:

> In certain limited circumstances, which the agency may cover in its procedures under S 1507.3, the agency shall make the finding of no significant impact available for public review . . . for 30 days before the agency makes its final determination whether to prepare an environmental impact statement and before the action may begin. The circumstances are:
>
> *　　　　*　　　　*
>
> (2) The nature of the proposed action is one without precedent.

(Emphasis added). CEQ has interpreted this rule as mandating public review "if it is an unusual case, a new kind of action, or a precedent setting case such as a first intrusion of even a minor development into a pristine area" or "when there is either scientific or public controversy over the proposal." Forty Questions, Question 37b.

The Department of Defense's NEPA regulations, applicable to ARPA, provide:

> *Public Participation.* DoD Components shall involve environmental agencies, applicants, and the public, to the extent practicable, in preparing environmental assessments. In determining "to the extent practicable," factors that may be considered include:
>
> a. Magnitude of the proposal,
> b. Likelihood of public interest,
> c. Need to act quickly,

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d. National security classification issues.

32 C.F.R. Part 188, Enclosure 1, paragraph 3 (emphasis added).[1]

That there is substantial controversy concerning all aspects of ATOC is obvious; this, presumably, is precisely why the public is being excluded from the process. As far as we know (that is to say, as far as you have informed us), the AET is "without precedent." (If not, there is no need to repeat a test that has been previously performed.) Now that the test plans have been disclosed, we are informing you that there is "substantial interest" in a hearing.

In the face of these legal requirements, there is no excuse for persisting in performing the AET without a hearing and without public comment. The law does not exempt from the NEPA process agencies or applicants who wish to preserve their funding.

In addition to the violations of NEPA's procedural requirements that will result from conducting the AET in the absence of a programmatic EIS and a comment period on the EA, Scripps and ARPA will also be courting violations of the MMPA and ESA. Scripps' October 24 press release claims that "the AET experiment protocol is designed to eliminate any potential effects on marine mammals from sound transmissions during the test," but this is obvious hyperbole. Indeed, that the AET will likely harass marine mammals - including the endangered sperm whale - is evident from Dr. Fox's October 21, 1994 letter to Dr. Alewine (the "Fox Letter") and the EA. The Fox Letter points out: "Ideally for reducing possible harassment of marine mammals, a location away from the sea mount would be preferred, however, this would not serve in testing sound propagation near the bottom. For that reason, when testing in the vicinity of the Seamount, the recommended mitigation measures described below should be closely followed to avoid potential marine mammal harassment."

Clearly, the protocol was <u>not</u> "designed to eliminate any potential effects on marine mammals." It was designed to allow

---

[1] We are aware that 32 C.F.R. Part 188 purports to be limited to DoD activities with environmental effects in the United States. Since the marine mammals that would suffer adverse impacts as a result of the AET would almost certainly be migrating through United States waters, the environmental effects will be felt in the United States. Any argument to the contrary would not only underscore that ARPA is grasping at technical straws to avoid public disclosure, but fuel the suspicion that the AET sites were selected in part for that purpose.

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Scripps and ARPA to test the ATOC sound source in an area where they might obtain sound propagation data, while avoiding the public scrutiny associated with testing in an area more densely populated with marine mammals.

It is equally apparent that "any potential effects" on marine mammals will not be "eliminated" by following the protocol. The methods proposed for detecting marine mammals in the test area are far from foolproof. According to the Fox Letter, the "field of modified behavior" - that is, the zone of harassment - is an area of 1,257 square kilometers surrounding the source at a depth of 700 meters at the deep-test site, and an area of 2,827 square kilometers at the Jasper Seamount. The suggestion that the combination of visual sighting from a single location and acoustic monitoring of those marine mammals that happen to be vocalizing will ensure, even during the daytime, that these vast areas will be free from marine mammals prior to transmission of the acoustic signal is, frankly, absurd.

Dr. Fox points out in his letter that "not all whales vocalize all the time," and expresses NMFS' "concern" that "acoustic monitoring may not be able, by itself, to ensure detection of all mammals" - and Dr. Fox is referring to detection within a "surface safety zone" only 1/225th the size of the zone of harassment. Dr. Fox therefore stresses the need for visual sighting, and notes the increased difficulty of effective visual sighting at night (since ARPA and Scripps insist upon continuing their experiment around the clock.) The use of an infrared scope for nighttime sighting does not solve the problem. Aside from the practical impossibility of ensuring that a huge area is free of marine mammals using a nightscope (to view the irregular surface of open ocean, no less), the EA and the Fox Letter reveal that the zone of harassment at depth is far larger than the zone at the surface. It is plain from the Fox Letter that, given the maximum range of 25-power binoculars, the area that could conceivably be covered by visual detection is only a small fraction of the zone of harassment beneath the surface (in the case of Jasper Seamount, about one seventh.) Not only is acoustic detection of whales inherently unreliable because, as Dr. Fox notes, "not all whales vocalize all the time" (and, as the Heard Island Feasibility Test showed, may be even less likely to do so in the presence of disturbances in their environment), but it is unclear whether acoustic monitoring is effective at all once transmission begins. Moreover, according to the EA, Scripps will not terminate transmission unless it happens to detect a marine mammal within 10 km of the "deep site" or within 15 km of the Jasper Seamount site. Yet, according to the Fox Letter, the zone of harassment extends twice these distances from the sound source at a depth of 700 m. Finally, suggesting that marine mammals disturbed by the transmission could avoid or swim out of the area, as does the EA, is simply another way of saying

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that any whales that are harassed by the AET can leave if they don't like it. If this occurs, Scripps and ARPA will be in violation of ESA and MMPA. Pointing out in an EA that harassment may well occur, and then finding that there will be no significant impact and no permits will be required, flouts the law.

NMFS' laissez-faire approach to the AET, despite its expressed "concerns" and the fact that implementation of the suggested measures will not obviate their basis, is contrary to law and completely unacceptable. ARPA and Scripps, in plunging ahead with the AET in the face of the legal issues discussed herein, do so at their peril.

We repeat our requests for a programmatic EIS, for a public hearing, and for, at a minimum, a 30-day public comment period before the AET or any other field testing of ATOC goes forward.

Very truly yours,

Paul ~~H.~~ Achitoff

cc: Hawai'i/California Coalition on ATOC
Sen. Daniel Inouye
Sen. Daniel Akaka
Rep. Patsy Mink
Rep. Neil Abercrombie

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KAUAI FRIENDS OF THE ENVIRONMENT

P.O. Box 1183
Hanalei, HI 96714

[illegible], Co-chair
[illegible]
Fax [illegible]

[illegible], Co-chair
[illegible]
Fax [illegible]

November 4, 1994

Dr. Walter Munk
SIO/ATOC
Fax 619-534-8076

Dear Dr. Munk:

We of the Kauai Friends of the Environment are becoming increasingly distressed by recent revelations surrounding the ATOC project. In view of all that has transpired in the last eight months in the realm of the relationship between ATOC and the public and, in particular, the environmental community, we find it incredible that with the mere release (in an apparently very limited way) of an "ATOC Project Update" on October 24, 1994 (of which we received a copy only after specifically asking for it on October 27) you are starting two experiments without complying with the applicable laws. We therefore would like to bring the following facts to your attention and ask for your elucidation on the relevant matters.

1. Your sponsor, Dr. Ralph Alewine of the Defense Department, was informed (or rather admonished) by Dr. William Fox of the National Marine Fisheries Service (NMFS) in a letter dated October 21, 1994, that "... it is each federal agency's responsibility to conduct an environmental analysis on their activity under the National Environmental Policy Act (NEPA). ... We look forward to reviewing this EA when it is available." Our best information as of the date of this communication is that no EA has been issued. Even if an EA had been issued in the past few days, the law requires a public comment period of thirty days. Yet your press release announces that the AET will begin on November 9, 1994. What is the legal basis for this decision to go ahead without complying with NEPA?

2. Your sponsor, Dr. Ralph Alewine, apparently was not totally unaware of the need to meet certain statutory requirements before conducting the AET, as evidenced by his letter of September 8, 1994 to Dr. Fox of NMFS asking for a review of the AET and a determination of no significant impact. It was this and certain subsequent letters from Dr. Alewine to Dr. Fox that apparently prompted the latter to inform your sponsor of the need for an EA. Is there some breakdown in communication between the operational side of ATOC and your sponsor?

3. Dr. Fox seems to go out of his way to be helpful to the ATOC project, going into great detail in his October 21 letter to Dr. Alewine on how the AET might avoid impact on marine mammals. Dr. Alewine, on the other hand, obviously is respectful of Dr. Fox's advice, judging by his several letters to NMFS. Therefore, one would expect that Dr. Fox's recommendation that AET sound transmission be terminated whenever marine mammals are

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sighted or acoustically detected within the "field of modified behavior", which, according to Dr. Fox, extends to 10 km at the deep-test site and 15km at the Jasper Seamount site. Yet your October 24 Update states that transmission will be terminated if "an observed animal approaches with 2 km." This significant discrepancy seems to run counter to the claims in your October 21 update that "The test plan has been reviewed by NOAA, the governing agency of the NMFS, the permitting agency." Can you explain what is meant by the above quoted statement that the test plan has been reviewed by NOAA. Does "review" constitute "approval"? Or is this statement intended to convey to the public the notion that the ABT has some sort of "approval" when in fact there is none?

3. Your October 24 Update further claims "The preliminary test is designed with a number of mitigation measures to be monitored closely by observers selected jointly by National Marine Fisheries Service (NMFS) and the MMRP." and "An environmental assessment has been prepared." We have no evidence from documents obtained to date that either of these two claims is based on fact. An *environmental assessment* that has been "prepared" does not mean that it has been published and presented to the public for comments. Again, as in the language cited in the preceding paragraph, such statements are apparently put forth to provide "palpable deniability" when challenged. Can we expect some "straight" answers unprotected by such palpable deniability?

4. With regard to the Playback Experiment to be conducted off Kauai there have arisen several questions related to the supposed existence of an applicable permit from NMFS, ostensibly Permit No. 813 issued to Adam Frankel of the University of Hawaii. It is our understanding that this permit, first issued on February 1, 1993 and subsequently modified to extend its expiration date to September 30, 1994, does not cover all the types of marine mammals that are to be encountered in the Kauai test, so that a new permit is now sought. Please clarify the status of the permit situation, with unequivocal language.

5. The language used in justifying both of these recently announced experiments seems to suggest that they would provide significant data for the preparation of the environmental impact statements. Does this mean that you will defer the issuance of the EIS's at least until results are in from these two experiments? In a separate Project Update released also on October 24, 1994 the ATOC project announced that the federal and state EIS's for California would be released in November (presumably 1994) and the Hawaii EIS's in December. Clearly these releases will far precede the outcomes of the two experiments. Please explain the apparent contradictions?

It is very unfortunate that, despite promises repeated often by ATOC officials, there has been a consistent lack of meaningful and timely disclosure to the public of ATOC activities and plans. We did not learn of the Playback Experiment plans from ATOC; the news came in a roundabout way via the Internet. KPOE had no communication from ATOC until a fax was sent to you on October 17, which prompted a telephone conference initiated by you (along with Dr. Forbes and Mr Rogers) with us on October 18, during which you agreed to make public your plans. You did not mention anything about the Baja California experiment even then. Neither we nor our legal counsel, the Sierra Club Legal Defense Fund, received the ATOC Update of

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October 24. We, as well as the Kauai Times, had to call you to get a copy of the release. We are puzzled by this apparent effort to limit the dissemination of information. At this point we are resigned to depending on the Internet and the probable existence of a "mole" within ATOC to find out what goes on.

In all this murky water surrounding ATOC there seems to be one shining light in the person and intellect of Peter Tyack who, in an illuminating discussion of the issues confounding ATOC, concludes with the sagely comment "My personal view is that neither whales nor users of sound in the ocean are likely to benefit if this issue is resolved in the courts." We agree wholeheartedly with Dr. Tyack!

Any light you can shed on the questions raised in the paragraphs above will be deeply appreciated by the environmental community.

Sincerely yours,

Raymond L. Chuan

Raymond L. Chuan, Co-chair
Kauai Friends of the Environment

cc: SCLDF
Rep. Patsy T. Mink
Dr. Ralph Alewine
Dr. William Fox

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May 14, 1994

Dr. Ralph W. Alewine, III
Director, Advanced Research Projects Agency
Nuclear Monitoring Research Office
3701 North Fairfax Drive
Arlington, VA 22203

Dr. William W. Fox, Jr.
Director, Office of Protected Resources
National Marine Fisheries Service
1335 East-West Highway, Room 13130
Silver Spring, MD 20910

Re: ATOC Project, Pt. Sur, California
<u>Research Permit Application P557 and P557A</u>

Dear Drs. Alewine and Fox:

The Mid-Pacific (Honolulu) and San Francisco Offices of the Sierra Club Legal Defense Fund ("SCLDF") jointly provide the following comments on the Acoustic Thermometry of Ocean Climate ("ATOC") Project, Scientific Research Permit ("SRP") Applications proposed by the Scripps Institute of Oceanography, Institute for Geophysics and Planetary Physics ("Scripps"), for the waters off Pt. Sur, California (P557A), and Kaua'i, Hawai'i (P557).

We provide these comments on behalf of a coalition of the following 19 organizations: Save Our Shores, The Fund for Animals, Great Whales Foundation, Greenpeace, In Defense of Animals, Earth Island, Friends of the Sea Otter, Surfrider Foundation, Surfers' Environmental Alliance, People for the Ethical Treatment of Animals, Hawai'i's Thousand Friends, Life of the Land, Sierra Club -- Hawai'i Chapter, Animal Rights Hawai'i, Hawai'i Audubon Society, Citizens Against Noise, Save Our Surf, Kaua'i Friends of the Environment, and the Hawai'i Fishermen's Foundation.

These comments on behalf of the coalition are offered in addition to oral and written testimony submitted by the Mid-Pacific Office of SCLDF (1) on April 14 and 15, 1994, at the Hawai'i public hearings

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on April 14 and 15, (2) on April 29, 1994 (supplemental written comments on the SRPs submitted to Dr. Fox), and (3) May 6, 1994 (supplemental Environmental Impact Statement ("EIS") scoping comments submitted to Dr. Fox). We incorporate those comments by reference here.

INTRODUCTION

As you know, we have consistently argued for the need to conduct a full and comprehensive review of the environmental impacts associated with the ATOC program. As outlined in our April 14 and May 6 comments, the National Marine Fisheries Service ("NMFS") and the Advanced Research Project Agency[1] ("ARPA") of the U.S. Department of Defense have an obligation under the National Environmental Policy Act ("NEPA") to prepare a comprehensive programmatic environmental review that evaluates the cumulative impacts of the ATOC proposal.

The obligation to conduct a programmatic review exists separately from, and in addition to, the obligation to prepare site-specific EISs, such as those that are in preparation for the Kaua'i and Pt. Sur projects. The focus of the environmental reviews now being conducted are the scientific research permit applications submitted to NMFS, each of which requires careful and intensive scrutiny, as explained in detail below. The scope and potential impact of the larger program demands a separate and comprehensive environmental review, however.

Incredibly, the larger ATOC program has thus far escaped any environmental review, despite the fact that $56 million in federal funds have been allocated to the Acoustic Monitoring of Global Ocean Climate program of the Strategic Environmental Research and Development Program ("SERDP"), for the period 1992-1995 ("Phase I"). $32 million of this is to be allocated to ATOC[2], with the balance directed to the related Global Acoustic Mapping of Ocean Temperature effort. Of ATOC's $32 million Phase I funding, $21 million had been expended as of 12/31/93. An additional $50 million in federal funds are to be

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[1] Many concerns have been raised during the public comment period about the role of the Department of Defense, and in particular the Nuclear Research Monitoring Office, in funding and administering this project. The EIS must fully disclose why these agencies are sponsoring this research.

[2] The ATOC Revised Scope of Work (December 15, 1993) at 3 lists 18 institutions that are receiving funds for ATOC Phase I work, totalling $35 million.

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spent on the Global Ocean Climate program between 1995 and 1997 ("Phase II"), for a total of $106 million between 1992 and 1997. See ATOC Financial Status Report for the period 10/1/93 through 12/31/93; Global Ocean Climate Briefing Prepared for the SERDP Science Advisory Board, January 26, 1994 (hereinafter "Science Advisory Board Briefing").

The ATOC project and the related Global Ocean Climate programs funded and administered by ARPA clearly qualify as major Federal actions, which, as we review in detail below, may have very significant impacts on the quality of the human environment. Major Federal actions can include

> "federal or federally assisted research, development or demonstration programs for new technologies . . . [Environmental Impact] Statements shall be prepared on such programs and shall be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives." 40 C.F.R. § 1502.4. (emphasis added).

U.S. Representatives Patsy Mink and Neil Abercrombie expressed their dismay over the fact that federal funds had been expended without public notice, and without preparation of an environmental review, and called for a full explanation of spending to date, and the authority under which it took place. See Joint Statement by U.S. Representatives Patsy Mink and Neil Abercrombie to NMFS, April 15, 1994. We share their dismay, and call for a halt to any additional spending by ATOC, GAMOT or other components of SERDP's Global Ocean Climate project, until such time as a comprehensive, programmatic environmental review is completed.

A review of the scope of the Ocean Climate Program and its ATOC components clearly highlights the need for a programmatic EIS. According to the Acoustic Monitoring of Ocean Climate Phase 2 Proposal Overview (hereinafter "Phase 2 Proposal"), dated January 16, 1994, at 4, plans are in place for expansion of the ATOC network to the Indian Ocean, southern Atlantic and north Atlantic basins in a phased effort beginning in 1995; an Atlantic ocean experiment to explore acoustic path options is slated for late 1994. These efforts will include significant international participation by research institutions in 11 countries. See Science Advisory Board Briefing.

Expansion of the ATOC network in this manner has the potential not only to increase the significance of total impact on the species already going to be affected by the Kaua'i and Pt. Sur portions of the project, but also to impact many

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additional species of marine mammals, sea turtles and other marine life.

The Pt. Sur and Kaua'i ATOC projects are key elements in the development of the global network, and in the development of "models to predict the effects of man-made noises on marine mammals." ATOC SRP App. P557 at 11, SRP App. P557A at 15. If the California and Kaua'i projects prove successful, researchers clearly intend to expand the scope of ATOC. In addition, the Phase I effort currently funded by ARPA includes elements that contribute significantly and directly to the establishment of that global network, including its overall design. See ATOC Technical Proposal, Volume I at 65. Other elements of Phase I include International Hardware Development and Network Operations that are intended to provide assistance for development of a Russian source, and testing and installation of receivers in Tahiti, New Zealand, Taiwan and Australia. ATOC Technical Proposal, Volume I at 70.

In addition, the ATOC Grant Application (Vol. 1: Technical Proposal) indicates that the currently funded Phase I work includes a third sound source:

> "we specifically propose to undertake the following: (1) to procure three low frequency sound sources . . . and to install and operate first two of these, and then the third after reliable operations are established."

Technical Proposal at 8 (emphasis added).

The Grant Application makes numerous references to procurement of three sound sources, of the potential for selection of alternate sites (in addition to Kaua'i and Pt. Sur), and to possible placement of the third sound source on the east coast of Japan. See ATOC Grant Application Vol. 1 at 26; Vol. 2 at 4 and App. C; Vol. 3 at 3. It is clear, therefore, that the impacts of the ongoing Phase I of the ATOC program are not limited to the Pt. Sur and Kaua'i projects currently under review.

NEPA expressly requires EISs to consider cumulative actions, "which, when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." 40 C.F.R. § 1508.25(a)(2). As a result, NMFS and ARPA must consider not just the impacts of either the Kaua'i or Pt. Sur portions of the project in isolation, but also the impacts of a possible third sound source, and the cumulative impacts of an enlarged, potentially global network. Such a review could best be achieved via a programmatic EIS, with "tiered" site-specific

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EISs that address impacts at Kaua'i and Pt. Sur. NEPA regulations specifically recommend preparing a programmatic EIS for "federally assisted research, development or demonstration programs for new technologies which, if applied, could significantly affect the human environment." 40 C.F.R. § 1502.4(c)(2).

A comprehensive evaluation is critically important if informed decisions are to be made regarding the site-specific ATOC permit applications. The NEPA process is itself expressly intended to "help public officials make decisions that are based on an understanding of environmental consequences, and take actions that protect, restore, and enhance the environment." 40 C.F.R. § 1500.1(c). Accordingly, we view this scoping process on the EIS as only the first step toward a decision by NMFS and ARPA to prepare a comprehensive, programmatic EIS that will allow NMFS and the public to understand fully the consequences of the ATOC proposal, the larger Global Ocean Climate program, and to take appropriate actions in response.

At this time we again vigorously protest the hasty and apparently last-minute environmental review process being guided by the NMFS and ARPA. In our previous comments, focusing on the Kaua'i proposal, we expressed our concerns about the lack of notice to the public and the limited information available on the ATOC proposal. Regrettably, this situation has not changed. Despite the public and private meetings in which Scripps has been involved or has set up through its public relations firm, the public is still being left out in the cold and not provided vital information about this project in a timely manner to allow for a truly deliberative public review process.

We note with dismay that the decision to prepare an EIS for the Pt. Sur project was made public via a Federal Register notice dated May 3, 1994, less than two weeks before the May 16, 1994 public hearing. This leaves scientists, environmental groups, and members of the public wholly inadequate time to evaluate and prepare comments on this complex project.

In addition, we have encountered great difficulty even obtaining a copy of the ATOC proposal for Pt. Sur. We first requested a copy of application P557A in an April 12, 1994 Freedom of Information Act ("FOIA") request to NMFS. We renewed that request in our April 14, 1994 SRP application comments. On April 21, 1994, we submitted a request to Dr. David Hyde of Scripps asking for various documents, including a copy of SRP Application P557A. Most recently, on May 5, 1994 we requested a copy of SRP Application 557A from Carol

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Fairfield of NMFS' Protected Species Office, who assured us it would be mailed as quickly as possible.

Despite these many requests, we did not receive SRP Application P557A until May 12th (a mere four days before the hearing), and received some of the supporting documents that we requested from Scripps on May 13th. The failure to provide the SRP application in a timely manner, but at the same time rush forward with the hearing, makes a mockery of the hearing and scoping process. Access to the permit application and other supporting information is obviously crucial and must be assured <u>prior</u> to holding public hearings on these permit applications.

We have also just learned that Scripps will be proposing a modification of both the Kaua'i and Pt. Sur ATOC projects, that will split these into a "biological phase" (part I) and an "implementation phase" (part II). While we have yet to hear the details of this modification, the extremely last-minute timing of the announcement, coming on the eve of the public hearing, is very disturbing.

This "ambush" strategy further confirms our existing concerns that the project is being rushed ahead at the expense of necessary and important public disclosure and thoughtful deliberation. We therefore reiterate even more vigorously our request that <u>additional public hearings be held</u> in Santa Cruz, in Honolulu and on Kaua'i after the draft EISs issue, to allow the public sufficient time to engage in an intelligent dialogue with the appropriate agencies on this very important issue. Moreover, we request that the public comment period for scoping comments be extended until 30 days after Scripps provides, in writing, the details of the new "modified" proposal to the public.

In addition, as part of the scoping process, NMFS and ARPA must clearly indicate the relationship between the timing of the preparation of the environmental analyses and the agency's planning and decision making schedule. 40 C.F.R. § 1501.7(a)(7). This is particularly important with respect to the relationship between the Pt. Sur and Kaua'i projects, and plans for an analysis of the impacts of the larger ATOC network. This has not yet been done, nor was it addressed at either of the public hearings in Hawai'i.

We reiterate that, ultimately, <u>the decision to rush the deliberations</u> -- regardless of whether it is intentional or not -- <u>does a grave disservice not only to the public, but also to the project itself</u>. <u>If</u> the ATOC project is, as Scripps claims, a valuable new scientific method to study global climate change, and <u>if</u> the marine mammal research project is, as the marine mammalogists working with Scripps claim, completely benign, <u>then</u>

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the public disclosure and deliberation process will engender public support and work to the long-term advantage of the project proponents.

Even NMFS and Scripps should agree that the utmost caution should be used in starting a project that has unknown consequences on marine species that have the highest levels of protection afforded by our nation's environmental laws. The ATOC project must be put on hold while the environmental review process is followed to the fullest extent possible. Only then will the public be satisfied that these precious marine species -- who cannot speak for themselves -- are not being put at risk in the name of science or for the sake of arbitrary budgetary constraints.

I.

BACKGROUND: THE PERMIT APPLICATION

According to NMFS' and ARPA's May 3, 1994 notice of intent to prepare an EIS for Pt. Sur (P557A), the ATOC Program is requesting authorization to "take" by harassment a multitude of species of cetaceans, pinnipeds, and sea turtles in California coastal waters.[3]

The February 3, 1994 permit application to NMFS for an SRP (P557A) under the Marine Mammal Protection Act ("MMPA")

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[3] The 22 species of marine mammals to be taken include: blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. borealis*), minke whale (*B. acutorostrata*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), right whale (*Eschrichtius robusrus*), sperm whale (*Physeter macrocephalus*), beaked whales (*Ziphius cavirostris, Berardius bairdii, Mesoplodon spp.*), killer whale (*Orcinus orca*), Risso's dolphin (*Grampus griseus*), common dolphin (*Delphinus delphis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), northern right whale dolphin (*Lissodelphis borealis*), bottlenose dolphin (*Tursiops truncatus*), Dall's porpoise (*Phocoenoides dalli*), striped dolphin (*Stenella coeruleoalba*), harbor porpoise (*Phocoena phocoena*), northern elephant seal (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*). SRP Application P557A, p. 2. The SRP does not identify the sea turtles to be taken, but at least five species -- loggerhead (*Caretta caretta*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys*) and hawksbill (*Eret mochelys imbricata*) -- are known to inhabit the Pt. Sur area.

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provides a limited description of the project background. Scripps is undertaking a federally sponsored, international research initiative to measure long-term ocean climate changes on global scales using deep ocean acoustic sound paths to measure ocean temperatures[4]. Scripps proposes to install two acoustic transmitters and a series of receivers throughout the Pacific over a two-year period (1994-1995) to assess the feasibility of a broader global ocean climate monitoring program. As far as we know, no ATOC transmitters have yet been installed at any locations.

The source transmitter near Pt. Sur would be located at 850-950 meters depth, 40 km west of Pt. Sur. Scripps proposes to transmit a low frequency signal centered at 70 Hz, with a bandwidth of 20 Hz and a band level of 195dB re 1 uPa. During "normal" operations, the transmissions would last 20 minutes and be repeated every four hours at a maximum rate of 6/day (8% duty cycle)[5].

The Marine Mammal Research Project is divided into four tasks. Task 1 would collect passive acoustic data on vocalizing blue whales (sperm and humpback whales would also be tracked if present in the ZOI) from both horizontal and vertical line arrays mounted on the seafloor. Task 2 would require the "tagging" of various indicator species, including blue whales, sperm whales, northern elephant seals, and California sea lions in order to conduct satellite monitoring of at-sea behavior patterns and to verify acoustic tracks. Task 3 would track sperm whales and other odontocetes using hydrophones from a vessel. Task 4 involves aerial and vessel surveys of marine mammals with special attention given to sperm whales.

The Kaua'i portion of the ATOC project is very similar to the portion proposed at Pt. Sur. Our comments of April 14 and 15, 1994 describe application P557.

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[4] As noted above, background documents, including the ATOC Scope of Work, indicate <u>three</u> sound sources will be used.

[5] This is contradicted by the ATOC Scope of Work, which states (Vol. 1 at 45): "Duty cycles will vary from 2% to 10% during normal transmissions; a duty cycle of up to 30% will be tested during habituation experiments." The Scope of Work also makes reference to transmission at 200 dB. *Id.*, at 49.

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II.

NMFS MUST DENY THE PERMIT
AND CANNOT RECONSIDER ANY REAPPLICATION
UNTIL AFTER COMPLETION OF THE ENVIRONMENTAL IMPACT STATEMENT

As we stated in our April 29, 1994 comments, NMFS must render a final decision on Scripps' application for an SRP within 30 days after the public hearing on the permit. As expressly directed by Congress in the MMPA, Section 104(d):

> As soon as practicable (but not later than thirty days) after the close of the hearing or, if no hearing is held, after the last day on which data, or views, may be submitted pursuant to paragraph (2) of this subsection, the Secretary shall issue a permit containing such terms and conditions as he deems appropriate, or (B) shall deny issuance of a permit.

16 U.S.C. § 1374(d)(5) (emphasis added). See also 50 C.F.R. § 216.33(c) and § 222.24(c) (same).

Therefore, NMFS has no discretion to delay decision on the Pt. Sur permit application after June 15, 1994. (Similarly, for the Kaua'i application, a decision from Scripps is due on May 16, 1994 -- 30 days after the close of the April 15, 1994 hearing.)

We understand that there continues to be discussion that Scripps might consent to a delay in processing of the permit application. However, we emphasize again that neither the MMPA nor the NMFS' regulations allow for such an extension of the processing time.

Thus, NMFS must make a final decision on permit P557A no later than June 15, 1994. Given the very serious scientific and public controversy over this permit application, NMFS really has no choice but to deny the permit.

The issuance of the SRP prior to completion of the EIS process now underway would not only violate the MMPA, because of the defects in the permit application (detailed below), but also NEPA, whose very purpose is to ensure that agencies and the public have the benefit of the full disclosure of information generated by the EIS prior to making a decision on the project. (It would also violate the consultation provisions of Section 7 of the Endangered Species Act, 16 U.S.C. § 1536, as discussed more fully below.)

As explained in the regulations promulgated by the Council on Environmental Quality ("CEQ"):

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> NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. . . . The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.

40 C.F.R. § 1500.1(b) (emphasis added).

To further this fundamental purpose of NEPA, the regulations specifically prohibit federal agencies from making an irrevocable commitment of resources -- such as issuance of a permit -- prior to completion of the EIS process.

> Until an agency issues a record of decision . . . no action concerning the proposal shall be taken which would: (1) Have an adverse environmental impact; or (2) Limit the choice of reasonable alternatives.

40 C.F.R. § 1506.1(a).[6]

Indeed, the very purpose of NEPA would be directly violated if NMFS issued the permit as it now stands.

> The primary purpose of an environmental impact statement is to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the Federal Government. It shall provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.

Id. § 1502.1.

In addition, under the substantive criteria set forth in the MMPA and the NMFS regulations, the permit must be denied under these circumstances. In 1988, Congress amended the MMPA to tighten the restrictions on SRPs. Now, Section 104(c) of

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6 We explain above why a "programmatic" EIS is required for the ATOC project, which apparently involves 11 major research institutions, 7 countries, and several transmission and receiving sites. The NEPA regulations similarly bar agencies from committing resources while a programmatic statement is underway. 40 C.F.R. § 1506.1 (c).

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the MMPA states that the burden of proof with respect to an SRP application is squarely on the applicant:

> A permit may be issued for scientific research purposes only to an applicant which submits with its permit application information indicating that the taking is required to further a bona fide scientific purpose and does not involve unnecessary duplication of research.

16 U.S.C. § 1374(c) (emphasis added).[7]

As the storm of controversy over this and the Kaua'i permit demonstrates, Scripps has failed to make such a showing. Many researchers have expressed serious concerns over the merits of the ATOC marine mammal research, and questioned the precedent of granting research permits for a project whose primary purpose is not the study of marine mammals. See comments submitted to NMFS on SRP P557 and P557A by Scott Benson (March 4, 1994); Peter Tyack (March 20, 1994); Katharine Payne (March 21, 1994); and Kurt Fristrup. The Southwest Regional Office of NMFS has in fact recommended that the Scripps scientific research permit for Hawai'i be denied because "the proposed research is not 'bona fide.'" See our April 14 comments at 13.

Evaluation of the merits of this research has been further complicated by Scripps' last-minute modification to the research proposal, evidently splitting the project into two phases. At present, there is insufficient information on either the details of the modified research proposals or their merits to draw a conclusion with regards to whether the research is "bona fide", and thus eligible for a scientific research permit under the MMPA. Consequently, it would be quite difficult, legally, for NMFS to justify issuance of either permit at this time.

Perhaps after the completion of the EIS, during which alternatives are analyzed and full disclosure of potential impacts is made, Scripps may be able to meet the standards for issuance of an SRP.

However, at this time, issuance of both permit applications would be clearly premature. In short, NMFS must

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7 See National Research Council Report on "Low-Frequency Sound and Marine Mammals" (1994), at 31 ("Federal permit officials may take a very restrictive stance on what 'bona fide scientific purpose' or 'unnecessary duplication' is.").

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deny the permit for SRP P557A by June 15, 1994 (and SRP P557 by May 16, 1994) for at least three reasons: (1) it does not meet the statutory or regulatory criteria for an SRP for marine mammals; (2) even if it does meet the criteria, NMFS would be in violation of NEPA if the permit were to be issued prior to completion of the EIS; and (3) NMFS and ARPA would be in violation of Section 7 of the ESA, 16 U.S.C. § 1536 because there has been no formal consultation on the impacts of the project on listed species.

III.

NUMEROUS IMPORTANT SCIENTIFIC ISSUES REMAIN UNRESOLVED

Scripps' SRP application for Pt. Sur does not adequately discuss the numerous unresolved scientific issues related to this project, both in terms of ATOC's basic ocean temperature change research and the associated Marine Mammal Research Program ("MMRP").

The highly controversial nature of the scientific issues related to this project are emphasized in a recently issued statement joined by fifteen prominent scientists, and attached to our April 14, 1994 comments, who concluded that:

> information on the hearing sensitivities and on the diving abilities of most marine mammals is limited, and that we do not yet know what the subtle, long-term effects of noise on marine mammals might be. Given these uncertainties, we do not feel that it is prudent to proceed at this time with the ATOC experiment.

We concur in this analyses and recommendation, and urge NMFS and ARPA to consider it carefully.

A. Global Climate Change Research

Significant controversy exists regarding the measurement of global ocean temperature through the ATOC program. The Pt. Sur and Kaua'i portions of the ATOC project represent initial attempts to measure ocean temperature on an ocean basin scale. If successful, this information will used to validate predictive global oceanic climate models, which would be used in turn to design a global ATOC network with 10 or more transmitters placed worldwide. See Phase 2 Proposal.

Actual data on long-term ocean temperature trends -- the "proof" of global warming -- would take decades to collect. Such data would still not tell us anything about the causes of global warming, or necessarily lead to corrective actions. As

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Dr. Rodney Fujita, senior scientist with the Environmental Defense Fund has stated:

> Past evidence of an increasing trend in global average temperature (such as the global atmospheric temperature record, mass coral bleaching in the 1980s, and other indicators) have not proven sufficiently compelling to result in an adequate response to global warming (i.e., a commitment to policies that would significantly reduce greenhouse gas <u>concentrations</u> so as to limit warming to a rate and magnitude that would allow natural ecosystems to adapt).

Comments on SRP Application P557 and P557A, March 16, 1994, at 2.

A fundamental question that must be answered in the EIS, therefore, is even if ATOC works, will it produce significant action with respect to global warming? The potential impacts of the ATOC project, as well as the significant expense, require a full and critical evaluation of the project's purported benefits. A comprehensive analysis must include alternative methods by which the temperature data can be collected, and should address at least the following primary issues:

(1) Can meaningful information regarding ocean temperature be obtained via ATOC?

(2) Will that information lead to significantly better understanding of global climate change, and the causes of that change?

(3) Will such an understanding lead to corrective actions on the part of nations and individuals?

B. <u>Impacts on Marine Life</u>

The EIS must address the potential impacts of the ATOC sound source on <u>all</u> marine life, including species not addressed in Scripps' SRP application. The EIS must particularly address potential impacts to species listed as threatened and endangered under the Endangered Species Act, and to species which may serve as critical food sources for those threatened and endangered species.

1. <u>Lack of Knowledge Regarding Impacts Of Low Frequency Sound On Marine Mammals</u>

A fundamental issue of concern that must be addressed in

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the EIS is our lack of knowledge about the impacts of low-frequency sounds on marine mammals. The recently released study "Low-Frequency Sound and Marine Mammals - Current Knowledge and Research Needs," conducted by the Committee on Low-Frequency Sound and Marine Mammals, the Ocean Studies Board, and the Commission on Geosciences, Environment, and Resources of the National Research Council (hereinafter "NRC Marine Mammal Study") states (at 1):

> Data on the effects of low frequency sounds on marine mammals are scarce. Although we do have some knowledge about the behavior and reactions of certain marine mammals in response to sound, as well as about the hearing capabilities of a few species, the data are extremely limited and cannot constitute the basis for informed prediction or evaluation of the effects of intense low-frequency sounds on any marine species.

The SRP application submitted by Scripps for the ATOC project also refers to the lack of information and knowledge, stating (SRP App. P557 at 9, SRP App. P557A at 15):

> The marine mammal research proposed here is motivated by the fact that we do not yet know enough about the impact of the ATOC source on marine mammals to predict levels, areas, and scales of influence. Previous studies of marine mammal responses to man-made noises have examined short-term behavioral responses to broadband industrial and recreational vessel noise and there are no data on the potential effects of a sound with ATOC source characteristics.

In light of the lack of data on impacts to marine mammals, it is critical to fully analyze the potential impacts prior to initiating the ATOC project. This is particularly important for several reasons:

a. ATOC is ultimately slated to be global in scope, with ten or more sound transmitters, possibly operating for decades. The deep waters of the much of the world's oceans will be subjected to low frequency sound transmissions generated by ATOC. The potential impacts on marine mammal, turtle and fish populations are thus much greater than those being discussed for the initial projects off the coast of California and Kaua'i.

b. The long-term monitoring effort will require hundreds of millions of dollars and will involve researchers and agencies from a number of countries. Once begun, it will be very difficult to change the course of this massive effort,

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and even more difficult to halt it, even if data showing significant impacts on marine life are reported. The appropriate time to evaluate potential impacts is now, before the project is approved and begun.

c. The most significant potential impacts to marine life from the ATOC project are likely to be at the population level, in the form of reduced breeding success, and impaired communication, feeding, or other behavior that is critical to individual and population survival. Despite their importance, however, these population level impacts will not be monitored in the course of the either ATOC project:

> It is the intent of this program to determine whether significant or permanent impacts are possible on humpbacks, but at this time the research is designed to detect short-term changes in response to the ATOC source. (SRP App. P557 at 23; see also discussion in SRP App. P557A at 16-17, 47-48)

The ATOC project has focused on short-term behavioral shifts, despite the fact that these are not good indicators of long-term impacts:

> While short-term, surface-based measurements of changes in animal swim direction associated with received noise levels provide a good indication of startle response or transitory avoidance, they are unreliable for estimating long-term changes (e.g., increased activity, avoidance of critical habitat, interruption of feeding, or failure to find a mate for breeding). These long-term changes could have significant biological consequences. (SRP App. P557A at 16).

It is critical that a more complete understanding of the linkages between short-term behavioral changes and long-term population level impacts be understood prior to initiating a long-term project.

2. Sea Turtles

The following species of sea turtles are found in waters adjacent to Pt. Sur: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys*) and hawksbill (*Eret mochelys imbricata*). All are threatened or endangered. In particular, the leatherback sea turtle commonly inhabits the waters off Monterey Bay. Available research (see Balazs and Ross, 1974; O'Hara and Wilcox, 1990, Lenhardt et al 1983; and Ridgway et al 1969) indicates that sea turtles do respond to low frequency noise. It is therefore imperative that a full analysis of the

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potential impacts of the ATOC sound source on sea turtles be conducted. The Pt. Sur SRP application does not address this issue at all.

Sea turtle researchers (including members of the NOAA/NMFS Pacific Basin Sea Turtle Recovery Team) have indicated that the monitoring proposed in Scripps' SRP permit application will not be sufficiently sensitive to detect potentially significant behavioral changes, which may impact sea turtle populations, and ultimately sea turtle populations. NMFS Office of Protected Resources, Permits Division, has raised these concerns as well, (see April 12, 1994 letter from Ms. Ann Terbush to Dr. Christopher Clark, appended to our April 14, 1994 comments).

In its evaluation of impacts to sea turtles, the EIS must consider preliminary studies, to be performed before the ATOC sound source begins transmission. These studies would include credible studies of captive sea turtle response to low frequency sound and satellite tracking of turtles during their use of the waters off the California coast for breeding, feeding, resting, and migration. Such studies would allow an informed decision regarding probable impacts on sea turtles to be made; it would also provide a baseline of data (from satellite tracking) that could be used to measure impacts from the ATOC sound source, if the decision to proceed with the project were made.

3. Fish and Invertebrates

According to the NRC Marine Mammal study (at 53),

> Sound is important for normal behavior of many species of bony and cartilaginous fishes . . . Fish use sound for a variety of reasons, including but not limited to prey detection, intraspecific communication, maintenance of schools, and predator avoidance.

Recent research indicates that low frequency sounds are also associated with fish reproductive behavior (see for example Lobel 1992). The ear and lateral line organs, which detect acoustic and hydrodynamic signals, are thus very important to normal fish behavior, and "damage to these systems would severely affect [the fishes'] ability to survive and reproduce." NRC Marine Mammal at 53. Although little is known about the use of sound by marine invertebrates, at least some species are known to have highly developed systems for detection of sound.

Impacts on fish and invertebrates may be significant both ecologically and economically. If ATOC negatively impacted

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fish and invertebrate populations, secondary impacts could also be felt along the marine food chain, as reductions in invertebrates or fish may deprive marine mammals and other higher-level predators of important food sources. Reductions in fish populations may also have economic impacts, as there are many economically important fish species (including some that are deep-dwelling) found in California waters.

It is imperative that the EIS examine potential impacts to fish and invertebrates. Because of the lack of data on fish and invertebrate response to sound sources, the EIS must also consider preliminary studies, to be performed before the ATOC sound source begins transmission, which could form the basis for an informed decision on whether to proceed with the project, as well as providing baseline data prior, should the ATOC project proceed.

C. Suitability Of Pt. Sur And Kaihu Pt.
For ATOC Sound Transmission

In its evaluation of alternatives, the EIS under preparation by NMFS and ARPA must compare the potential impacts to marine life of the ATOC projects proposed for Pt. Sur and Kaua'i with a similar project conducted in other areas less rich in marine life.

According to Dr. Roger Payne, President of the Whale Conservation Institute:

> A further consideration makes it seem to me that the choice of both areas [Pt. Sur and Kaihu Pt.] for the broadcast of such intense sounds (lying well within the frequency band which whales can supposedly hear) is ill considered: both are well known areas, not just of the occurrence of whales and other marine mammals, but of their concentration. I believe it might be hard to choose two areas more likely to expose marine mammals to the test signal on such a regular, though unintentional, basis. . . . I would also urge that other areas which do not have such clear concentrations of marine mammals be chosen for the location of the transmitters.

Letter to Carol Fairfield, NMFS, March 25, 1994 (emphasis added).

It is critical that the discussion of alternatives in the EIS explore the feasibility of transmitting the ATOC signal from other locations, and evaluate the number of species and individual animals likely to be exposed and impacted by the signal if it is located in an alternate site.

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D. Inadequacy Of The ATOC Marine Mammal Research Program

The ATOC SRP Application P557A indicates that the ATOC MMRP will focus on collecting at-sea and aerial observations as well as passive acoustic and remote sensing data on mysticetes, odontocetes and pinnipeds. In addition, opportunistic visual observations of other marine mammal species and sea turtles will be conducted. It is critical that the ATOC MMRP be comprehensive, well designed and successfully implemented if it is to (1) function as a safeguard that ensures that transmission of the ATOC signal is immediately halted should significant behavioral changes be detected among monitored species; and (2) be used to "make models to predict the effects of human-made noise on marine mammals," as proposed by SRP App. P557A at 18 and P557 at 11. The EIS must fully consider at least the following concerns raised regarding the adequacy of the MMRP, evaluate alternatives to the proposed design, and assess the capability of the monitoring program to assess impacts on marine life as a result of the ATOC sound source.

The MMRP has been criticized as inadequate in a number of respects. The criticisms fall into three primary categories: the research program proposes to test an improper hypothesis, and consequently may lead to false conclusions regarding the impacts of the ATOC sound transmissions on marine mammals; the research design is seriously compromised by the requirements of the ocean climate monitoring program, with potentially significant negative impacts on both the research results and the marine mammals under study; and the MMRP is inadequate to detect important short-term behavioral changes in all potentially impacted specie, and does not begin to address critically important long-term behavioral changes.

1. ATOC Proposes Improper Hypothesis

The first criticism centers on the fact that ATOC proponents have not evaluated the likelihood of failing to reject a false null hypothesis. The research design assumes that the ATOC sound transmissions will have no significant effect on marine mammals (a null hypothesis), and proposes a monitoring program to determine if that hypothesis is accurate (i.e. it will seek to detect significant effects). At no time, however, is the ability of the monitoring program to detect such effects evaluated. The relatively small size of the blue whale population that is to be monitored (and the even smaller sample size of sea turtles, sperm whales, Pinnipeds and other marine mammals), combined with our lack of knowledge regarding the significance of various behavioral changes exhibited by humpback whales and other marine life in response to noise stimuli, increases the likelihood that the monitoring program will falsely conclude that the ATOC signal has no significant effect.

This is of particular concern because without statistically significant evidence that ATOC transmissions are causing significant impacts no changes in those transmissions are likely to be made. In addition, this research is intended to be used as a model for the response of marine mammals to low frequency sound, and a false conclusion may have impacts that reach far beyond the ATOC project now under consideration. As a result, it has been suggested that the ATOC MMRP design be reformulated to assume that significant impacts <u>will</u> occur, and that ATOC not be allowed to proceed until that assumption is proven false. <u>See</u> comments to NMFS on SRP Application P557 and P557A by: David Wiley (March 6, 1994) and Kurt Fristrup.

We heartily concur with this suggestion. Such an approach would be more appropriate especially since many of the species to be impacted (all the whales; all the sea turtles) are either threatened or endangered. In short, the burden should be on the permit applicant to demonstrate that the project will <u>not</u> harm these species before NMFS approves the permit.

The EIS should fully explore the likelihood that ATOC researchers may fail to reject a false null hypothesis, and consider the impacts that would stem from such a failure. In addition, revision of the research design to assume that significant impacts will occur should be considered.

2. <u>MMRP Compromised By Ocean Climate Requirements</u>

The second criticism of the research design is that it is compromised by the requirements of the ATOC program, with potentially significant negative impacts on both the MMRP research results and the marine mammals under study. Both the signal strength and playback schedule of the ATOC sound source have been selected in accordance with the needs of the ocean climate modeling project, and not the needs of the marine mammal monitoring program. As Dr. Kurt Fristrup comments:

> The playback schedule itself does not appear to have been selected on biological grounds. It is not explicitly tied to the locations, behaviors, or even the presence of animal groups under observation. It is not clear that the biological researchers will have the authority to initiate transmissions on demand, regulate their level or duration, or indefinitely suspend transmissions to document the restoration of pre-exposure conditions.

Comments to NMFS on SRP Apps. P557 and P557A.

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This issue is of critical importance for this research project, and also for the precedent that this project could set. "The proposed permit could establish a precedent of allowing "takes" under scientific research permits for any kind of activity as long as marine mammalogists are monitoring it." Peter Tyack, Comments to NMFS on SRP 557A (March 20, 1994).

The EIS must evaluate the viability of the marine mammal research, and consider how that research may be compromised as a result of being conducted in conjunction with the ATOC ocean climate program. In addition, a full evaluation of the potential for modification of the ATOC sound source, including variations in signal strength, duty cycle, and frequency levels, and resultant impacts on the ATOC ocean climate program should be included.

3. MMRP Unable To Detect Impacts To All Species

The third criticism of the MMRP concerns its ability to detect short-term behavioral changes in all potentially impacted species. A number of specific concerns have been raised with respect to this issue.

First, dedicated monitoring of only the blue whale, sperm whale, northern elephant seal and California sea lion is inadequate to assess impacts on other protected species that are or may be present[8]. The monitoring program should consequently be expanded to include additional marine mammal and sea turtle species. See comments submitted to NMFS regarding SRP 557 and/or 557A by Scott Benson (March 4, 1994), Linda Weilgart (March 22, 1994), and Hal Whitehead (March 22, 1994).

Second, no monitoring of impacts to non-listed, but nevertheless important species, including fish and invertebrates, is planned, despite the potential for impacts to these species. Such impacts could result in secondary impacts to protected species that are dependent on these as food

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[8] These species include: fin whale (*B. physalus*), sei whale (*B. borealis*), minke whale (*B. acutorostrata*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), right whale (*Eschrichitius robusrus*), sperm whale (*Physeter macrocephalus*), southern sea otter (Enhydra lutris nereis), guadalupe fur seal (Arctocephalus townsendi), steller sea-lion (Eumetopias jubatus), loggerhead sea turtle (Caretta caretta), green sea turtle (Chelonia mydas), olive ridley sea turtle(Lepidochelya olivacea), leatherback sea turtle (Dermochelya), and hawksbill sea turtle (Eretamochelys imbricata).

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resources, and economic impacts if ATOC negatively impacts commercially important fish resources. See comments submitted to NMFS regarding SRP P557 and P557A by Jim Darling (March 25, 1994).

Third, the monitoring program is inadequate to detect potentially significant behavioral changes to most species, and only dramatic behavioral changes are likely to be observed. In his comments on the SRPs, Jim Darling notes:

> At best only the most overt impacts on a few species will be recognizable. Even if broader observation regimes could be developed, the natural variability of behavior patterns in most, if not all, species are not well enough known to conclude a change in behavior is the result of the experiment or some other natural variable. Unfortunately, the experiment is far too big in proportion to our impact assessment capability.

Fourth, the MMRP places excessive reliance on acoustic tracking, and should be complement this technique with additional, proven survey methods. Scott Benson, a member of the biological team that participated in the Heard Island Feasibility test in 1991, has commented:

> The biological effect of the sound source should be considered in a thorough manner using proven technology. . . . Innovative use of hydrophone arrays and tracking systems as currently proposed should be complemented with rigorous and ample standard survey techniques in the event that the more modern techniques fail to yield results.

Scott Benson comments to NMFS regarding SRP P557A (March 4, 1994).

The EIS should evaluate these and all other concerns raised regarding the design and implementation of the ATOC MMRP during the EIS scoping and SRP application review process, including comments from the NMFS Southwest Region Office that the marine mammal research is not "bona fide," and the SRP should be denied as a result. See SCLDF April 14, 1994, ATOC SRP comments at 13.

E. Inadequate Discussion Of Protocol For Whale Tagging

The SPA permit application indicates that "Task 2" will involve the "tagging" of ten blue whales and possibly five sperm whales. Application, pp. 34-6. The application does not describe how this tagging will be accomplished, however, or

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what the physical tags will consist of, or how the tags will be physically attached to the whales.

Will boats approach the whales close enough to affix the tags manually? Will the whales be "shot" with the tags from a distance? Will the tags penetrate the skin? Will they remain permanently affixed to the animals? Any of these scenarios pose grave danger of harassment and/or harm to the whales.

These are matters of very serious concern to our clients and must be fully disclosed and discussed in the EIS. It is not acceptable to gloss over discussion of these critical issues by simple reference to an existing permit.[9]

F. Clarification Of Sound Source Control

ATOC researchers indicated during public meetings and SRP hearings held in Hawai'i that the Hawai'i ATOC MMRP results would be constantly evaluated, and sound transmission off Kaua'i halted or modified if significant impacts to monitored species were detected. The researchers were unable to definitively state, however, what will constitute a significant impact for purposes of control of the sound transmission.

In addition, they suggested a process in which the ATOC MMRP would notify NMFS of impacts to monitored species, make a "recommendation," and then NMFS would in turn might take appropriate action to stop or modify the sound transmission, if warranted. Researchers indicated that at that time (April 16, 1994) protocols for control of the sound source were still being developed. We have learned nothing since then to indicate that a different procedure is being proposed for the California ATOC project.

We are dismayed at the lack of clarity over what constitutes a significant impact, and the lack of protocols for control of sound transmission, despite the apparent intention to use MMRP monitoring results to modify or stop sound transmission, if such action is warranted. We also note that the SRP Application P557A makes no mention at any point of sound transmission control or modification as being among the research objectives.

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[9] In any event, we do not believe that an existing permit for other, unrelated work, can legally suffice for the new and expanded tagging envisioned in the Point Sur ATOC application. Rather, the proposed tagging of ten new blue whales and five sperm whales not covered in the existing permit would constitute illegal taking of listed species and requires a new and separate permit.

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The verbal statements of ATOC researchers are currently the sole indication we have that the ATOC sound transmissions may be influenced by the MMRP monitoring results. It is imperative that the EIS fully discuss this issue, analyzing the ability of the monitoring program to detect impacts, the decision process that will be used to evaluate the significance of any impacts, the protocols that will be established to communicate findings to NMFS and the ATOC ocean climate researchers, and whatever formal agreements will be in place to ensure that protocols are adhered to.

IV.

<u>FULL COMPLIANCE WITH THE ENVIRONMENTAL LAWS IS REQUIRED BEFORE THE ATOC PROJECT CAN PROCEED</u>

In addition to the numerous scientific and research related issues that have been raised and stand unresolved, there are an array of legal issues that deeply concern us. Our review of the environmental laws that are implicated by the ATOC project confirm, again, the conclusion that there has been wholly insufficient agency review of the potential environmental impacts of this project and that the applications may conflict directly with the laws protecting marine mammals and listed threatened and endangered species.

A. <u>A Full And Adequate EIS Under NEPA Must Be Prepared</u>

NMFS has only just recently determined that an EIS will be prepared for the ATOC-Pt. Sur project. (Notice of May 3, 1994.) According to that notice, the EIS will consider: (1) the potential effects of the proposed low frequency sound source on marine mammals, sea turtles, and other marine resources, including fish; (2) alternatives with respect to site selection; and (3) the purpose of the ATOC program and an evaluation thereof as compared to other possible alternatives for assessing global warming.

We are pleased that NMFS and ARPA will be preparing an EIS for this portion of the ATOC project. There is little doubt that it is a major federal action that may significantly affect the quality of the environment as contemplated by NEPA. 42 U.S.C. § 4332(C).

However, we are gravely concerned about the following issues:

First, the EIS process is being unduly rushed. As stated above, notice of scoping was only recently issued. According to the regulations of the Council on Environmental Quality

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("CEQ"), EISs (where appropriate) "shall be commenced no later than immediately after the application is received." 40 C.F.R. § 1502.5. In this case, a full three months passed between NMFS' publication of the application for a scientific research permit in the Federal Register and the decision to prepare an EIS.

Now, NMFS and ARPA appear to be in quite a hurry to convert rumored draft EAs (which have never been released to the public) into EISs. This last-minute review is inconsistent with NEPA and the CEQ regulations.

Second, according to the Scripps' scientists, the EIS is being done "voluntarily." This interpretation of the law is incorrect. NMFS and ARPA should make clear to Scripps that the EIS is being required by NEPA. Otherwise, the project proponent may later decline to fulfill all of NEPA's requirements and spark unnecessary controversy, if not litigation.

Third, NMFS and ARPA appear to be improperly limiting the scope of their NEPA review to EISs focusing on the California and Kaua'i ATOC projects. Under the CEQ regulations, proposals that are "related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement." 40 C.F.R. § 1502.4.

Moreover, as stated above, the regulations require that a "programmatic" EIS may be required for broad federal actions that have common timing, impacts, alternatives, methods of implementation, media or subject matter. 40 C.F.R. § 1502.4(c).

Indeed, the regulations specifically recommend preparing a programmatic EIS for "federally assisted research, development or demonstration programs for new technologies which, if applied, could significantly affect the human environment." Id., § 1502.4(c)(2).

> For such large-scale technology programs,
>
> Statements shall be prepared . . . and shall be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

Id., § 1502.4(c)(3). See also id., § 1502.20.

As we outlined above, a programmatic EIS, with "tiered" site-specific EISs, would be particularly appropriate here

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where NMFS has received two very similar permit applications from the same project proponent, and others are under consideration around the globe (including the Indian and southern Atlantic Oceans).

Fourth, it does not appear that Scripps is genuinely interested in exploring alternatives to either the proposed marine mammal research program, or, as suggested in the hearing notice, to the ATOC project itself. A full "alternatives" analysis is, of course, the "heart of the environmental impact statement." Id., § 1502.14. The analysis should "sharpen the issues" and provide a "clear basis for choice among options by the decisionmaker and the public." Id. (emphasis added). All reasonable alternatives must be explored in detail so that reviewers may evaluate their comparative merits.

Fifth, the EIS must discuss the possible conflicts of the ATOC project with the objectives of federal, regional, state and local land use plans, policies and controls. 40 C.F.R. § 1502.16(c). With respect to the California ATOC project, the EIS must carefully consider the implications for the Monterey Bay National Marine Sanctuary. The project may degrade the quality of the area to the extent that it may directly conflict with the purpose and intent of the Sanctuary, which is "to protect and manage the conservation, ecological, recreational, research, educational, historical and aesthetic resources and qualities of the area." 15 C.F.R. § 944.1; 57 Fed. Reg. 43310, 43315 (Sept. 18, 1992).[10] In addition, because the project has the potential to affect the California coastal zone, it is subject to the federal consistency requirements of Section 307(c)(3) of the Coastal Zone Management Act ("CZMA"), 16 U.S.C. § 1456(c)(3), and the applicant must prepare a "consistency certification" for review by the California Coastal Commission. See 15 C.F.R. § 930.57. The consistency of this project with California's coastal zone management programs should be discussed in the EIS.

Sixth, the EIS must clearly identify the factual areas where there is "incomplete" or "unavailable" information. Id., § 1502.22. Furthermore, on many of the issues raised about this project, the answer of "no information exists" will not be adequate. The agencies and applicant must undertake necessary

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10 The regulations implementing the Monterey Bay NMS prohibit, among other things, "Taking any marine mammal, sea turtle or seabird in or about the Sanctuary, except as permitted by regulations . . . promulgated under the Marine Mammal Protection Act, 16 U.S.C. 1361 et seq., the Endangered Species Act, 16 U.S.C. 1531 et seq., and the Migratory Bird Treaty Act 16 U.S.C. 703 et seq. See 15 C.F.R. § 944.5(a)(6).

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measure to obtain that information. Id., § 1502.22 (incomplete information that is essential to evaluation must be obtained if the costs are not exorbitant). If the costs of obtaining the information is excessive, then the EIS must explain the relevance of the incomplete information, summarize existing credible scientific evidence on the issue, and evaluate impacts using theoretical approaches or research methods that are generally accepted in the scientific community. Id.

Seventh, NEPA also requires that EISs include as part of the consideration of alternatives appropriate mitigation measures. § 1502.14. In the case of the ATOC EIS, the mitigation to be considered should include, at a minimum, a comprehensive monitoring program to be conducted in conjunction with, and for the duration of, any ATOC sound transmission. The EIS should also evaluate how that mitigation would be enforced, particularly in the case of ATOC transmitters that are placed in foreign or international waters, and may be funded and/or controlled by foreign governments or research interests.

Finally, we are concerned that the applicant may attempt to move ahead with the project while the EIS process is underway. We are aware that the funding for the project has a 30-month term. These circumstances lead us to conclude that, but for the EIS process and public pressure, the Pt. Sur ATOC project would have been commenced immediately.

NEPA prohibits the irrevocable commitment of resources to a project prior to the completion of the EIS process. Until a Record of Decision ("ROD") issues, no action may be taken that would have an adverse environmental impact or would limit the choice of reasonable alternatives to the project. 40 C.F.R. § 1506.1. Where the application is from a non-federal entity, it is the agency's responsibility to ensure that the applicant understands this directive of NEPA. Id.

We request that all of these issues be addressed in the Draft EIS and be taken into consideration in NMFS' review of the SRP.

B. NMFS And ARPA Must Conduct An Analysis Of Project Alternatives Under Section 102(2)(E) of NEPA

In a March 17, 1994 letter to NMFS (attached to our April 14, 1994 comments), NRDC explains the basis for its request than a Section 102(2)(E) "alternatives analysis" be prepared for the ATOC project because it presents "unresolved conflicts as to the proper use of resources." SCLDF concurs in this request, and urges NMFS and ARPA to proceed immediately to

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commence that process. The status of the alternatives statement should be discussed in the Draft EIS.

C. NMFS And ARPA Must Initiate And Complete Formal Consultation Under Section 7 Of The Endangered Species Act

Section 7 of the Endangered Species Act ("ESA") requires that every federal agency, including ARPA and NMFS, "insure" that "any action authorized, funded, or carried out" by such agency "is not likely to jeopardize the continued existence of" threatened or endangered species. 16 U.S.C. § 1536(a)(2). As a means of insuring that agencies carry out this crucial substantive duty, Section 7 also requires that agencies proposing to carry out, permit, or fund actions that may adversely affect listed species or their habitat must first consult either with the U.S. Fish and Wildlife Service or NMFS on the impacts to those species of such action. Id.

The consultation process usually involves preparation of a "biological assessment" by the agency proposing or funding the proposed action, and the issuance of a formal "biological opinion" by the Secretary of the Interior or Commerce, as the case may be. 16 U.S.C. § 1536(b), - (c).

Until consultation has been completed, Section 7(d) of the ESA prohibits both the agency and the permit or license applicant from "mak[ing] any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures" which would not jeopardize the continued existence of listed species. 16 U.S.C. § 1536(d).

The Point Sur - ATOC project is, we are led to believe, federally funded by ARPA and the Department of Defense (see next section). Consequently, ESA Section 7's jeopardy prohibition and consultation requirements apply even though Scripps itself is a non-federal organization.

We are not aware that either NMFS or ARPA have initiated or completed the consultation process. The EIS must disclose and discuss the status of consultation and the agency's timetable for completing that process. In the meantime, issuance of the permit and any work on or expenditure of funds in furtherance of the project would violate Section 7(d) of the ESA.

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V.

Budgeting And Involvement Of The Department Of Defense

As we have previously indicated, the SRPs for the California and Kaua'i projects fail to adequately disclose Department of Defense ("DOD") involvement in the proposed projects. An understanding of the scope and extent of DOD involvement is critical to the public's review of these research proposals. The EIS must include full disclosure of DOD funding, involvement in decision making, and any plans, commitments or discussions that have taken place regarding DOD funding of future ATOC projects, experiments or equipment development.

In addition, the EIS should disclose the extent to which ATOC intends to utilize DOD facilities and personnel in the course of the ATOC program. The SRP application does not adequately disclose the involvement of the Department of Defense and/or ARPA in the proposed project.

Finally, the EIS must disclose if there are any "dual uses" (i.e., both civilian and military applications) to the technology being used or developed through the ATOC project. For example, do the possible results of the ATOC project have useful application to submarine defense systems?

CONCLUSION

In conclusion, we have many serious concerns not only about the important and controversial scientific issues swirling around both of Scripps' permit applications, but also whether, how, and when these portions of the massive ATOC project will comply with the host of important environmental laws that protect the species at risk.

Please consider these comments as a request to deny SRP P557A and P557 on the basis that this is the only rational decision that can be made under the MMPA and NMFS' regulations, as well as NEPA -- the application cannot be considered legally until a full and adequate EIS is prepared. These comments should also be considered "scoping" comments pursuant to the May 3, 1994 notice of intent to prepare an EIS. You should be aware that organizations named above that are being represented by SCLDF for purposes of these comments may also be submitting their own supplemental comments and testimony, and that SCLDF may submit additional testimony based on the public hearings.

We also formally request that 20 copies of the Draft EIS be provided to us immediately upon publication so that we may

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distribute them to the above-identified environmental groups concerned about this matter.

In addition, we request that additional public hearings be held in Santa Cruz and on Oah'u and Kuai'i no earlier than 30 days (instead of only 15 days) after the Draft EIS has issued and at least one week prior to the close of the required 45-day public comment period. Under the NEPA regulations, public participation is strongly encouraged, and public hearings should be held where there is substantial environmental controversy concerned the proposed project or substantial interest in holding the hearing. There is little doubt that the Pt. Sur-ATOC project meets this criteria for holding additional public hearings.

We appreciate your careful consideration of the concerns that we and others have raised regarding these projects.

Very truly yours,

Denise E. Antolini
Staff Attorney
Mid-Pacific Office

Mark Smaalders
Resource Analyst
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cc: Hawai'i and California Coalition On ATOC
Hawai'i Congressional Delegation
California Senators and Central Coast Congressional Delegation


Sunrise, Mt McKinley — Ansel Adams

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BY MAIL AND FACSIMILE TRANSMISSION

May 6, 1994

William W. Fox, Jr.
Director, Office of Protected Resources
National Marine Fisheries Service
1335 East-West Highway, Room 13130
Silver Spring, MD 20910

Re: ATOC Environmental Impact Statement
Supplemental Scoping Comments

Dear Dr. Fox:

We submit the following supplemental Environmental Impact Statement ("EIS") scoping comments for the Acoustic Thermometry of Ocean Climate ("ATOC") project, Scientific Research Permit ("SRP") Applications P557 and P557A, proposed by Scripps Institute of Oceanography for the waters off Kaua'i, Hawai'i and Pt. Sur, California.

We provide these comments on behalf of the following nine organizations: Hawai'i's Thousand Friends, Life of the Land, Sierra Club -- Hawai'i Chapter, Animal Rights Hawai'i, Hawai'i Audubon Society, Citizens Against Noise, Save Our Surf, Kaua'i Friends of the Environment, and the Hawai'i Fishermen's Foundations.

These comments are offered in addition to oral and written testimony submitted at the Hawai'i public hearings on April 14 and 15, and our supplementary written comments on the SRPs submitted to your office on April 29, 1994. We incorporate those comments by reference here.

I.

Potential Incompatibility with the Hawaiian Islands Humpback Whale National Marine Sanctuary

The Oceans Act of 1992 sets forth the following policy:

> "It is the policy of the United States to protect and preserve humpback whales and their habitat within the Hawaiian Islands marine environment."

P.L. 102-587 § 2304. The Hawaiian Islands Humpback Whale National Marine Sanctuary was designated by Congress for that same purpose. The Sanctuary boundaries include, around Kaua'i, the waters to the 100 fathom isobath adjoining the Kilauea National Wildlife Refuge. However, consideration is currently being given to expansion of the existing boundaries in accordance with P.L. 102-587 § 2305(d). The Final Humpback Whale Recovery Plan considers the waters around all major Hawaiian islands to the 100 fathom isobath as essential habitat (see below).

The EIS for the ATOC SRP application must evaluate the potential incompatibility of the ATOC project with the declared policy of the United States, as quoted above, and with the protections and regulations of the Marine Protection, Research and Sanctuaries Act of 1972, as amended. These state, in part: "Federal agency actions internal or external to a national marine sanctuary, . . . that are likely to . . . injure any sanctuary resource are subject to consultation with the Secretary." P.L. 102-587 § 304. Full disclosure of compliance with this requirement is particularly important, in light of the fact that regulations pertaining to this section have yet to be promulgated. See Joint Statement by U.S. Representatives Patsy Mink and Neil Abercrombie on the Proposed ATOC Project Off Kauai, April 15, 1994 at 2.

II.

Conflict With The Recommendations Of The Humpback Whale Recovery Plan

The Final Humpback Whale Recovery Plan (hereinafter the "Recovery Plan") has been prepared by the National Marine Fisheries Service ("NMFS") in accordance with § 4(f) of the Endangered Species Act ("ESA") (16 U.S.C. 1531 et seq.), which provides that the Secretary of Commerce "shall develop and implement" recovery plans "for the conservation and survival" of listed species. 16 U.S.C. § 1533(f). Conservation of listed species means bringing them "to the point at which the measures provided pursuant to [the ESA] are no longer necessary" -- that is, to the point where they have recovered and can be removed from the list. 16 U.S.C § 1532(3). "Conservation" -- i.e. recovery -- is a central goal of the ESA, and the recovery plan is the key document that provides a roadmap for recovery for any particular species.

The Humpback Whale Recovery Plan states that its ultimate goal is to be "biologically-successful," which will be achieved when humpback whales occupy all of their former range "in sufficient abundance to buffer their populations against normal environmental fluctuations or anthropogenic environmental catastrophes." Recovery Plan at VI.(A). Downlisting of a population -- a measure of the "political success" of the plan -- "may be considered when [the humpback whales'] population dynamic parameters indicate that it is approaching the environmental carrying capacity." Recovery Plan at VI.(A).

The plan identifies two major ways to achieve growth in humpback whale populations: (1) protection of habitats and (2) reduction of human activities that interfere with annual life cycle processes. In discussing habitat, the plan makes the following recommendation (at VI (C)):

> 1.11 Identify essential habitat in Hawaiian waters. Coastal waters less than 100 fathoms deep around the main Hawaiian Islands are essential to humpback whales. These waters are of paramount importance for reproductive activities of the Central Pacific Stock, which includes the majority of humpback whales in the North Pacific Ocean. Since these waters are threatened by increased coastal development activities and possible habitat disruption, determination of appropriate protection for essential areas should be completed. (Emphasis added)

The plan also calls for action to identify and minimize possible adverse impacts of human activities and pollution on important habitat, calling for consideration of the possibility of "cumulative or synergistic interactions between various factors." Recovery Plan at VI (C)(1.3). A primary disturbance targeted for reduction by the plan is human-produced underwater noise:

> 1.3111 Reduce disturbance from human-produced underwater noise in Hawaiian waters and in other important habitats when humpback whales are present. Acoustic information is important in the life of the humpback whale. Feeding humpbacks may key in on sounds produced by other individuals or prey. Migrating

> humpbacks may listen for sounds produced by other individuals, animals on the bottom, or echoes of their own vocalizations. They may also listen for calls of killer whales (*Orcinus orca*), as warnings of the presence of those potential predators. The exact functions of calls produced by humpbacks on the winter range, and possibly at other times, are not fully understood, but they appear to have important functions in reproduction and social organization.
>
> Human-produced noises could potentially reduce information available to whales, physically disturb them, prevent them from carrying out some activities, or even displace them from preferred habitats. It is not possible to predict these impacts on humpbacks by generalizing from information known about other species. Some information is available for this species . . .. Additional research could be performed, but it is likely to be expensive and may provide ambiguous results.
>
> A more direct and cost-effective approach will be to work toward minimizing human-produced underwater noise, particularly in critically important areas such as Hawaiian waters or other winter ranges, but also at other locations when whales are present. (Emphasis added).

Both of the recommendations cited above are "Priority 2" recommendations, defined as actions "that must be taken to prevent a significant decline in the population or habitat quality of the species, or to prevent some other significant negative impact short of extinction." Recovery Plan at 90.

NMFS is under a legal obligation to carry out these recovery plan recommendations, and cannot grant a scientific research permit for the ATOC project if such a permit authorizes activities that are in conflict with the Recovery Plan. In order for NMFS to be fully informed before making a decision regarding the ATOC permit application, it is imperative that the EIS fully analyze these issues as well as the following specific questions:

> (1) What constitutes "appropriate protection" for essential humpback whale habitat in Hawaiian waters (defined by the plan to include waters up to 100 fathoms (600') around all the main Hawaiian islands)? Is positioning of the ATOC sound source off Kaua'i compatible with such protection?

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(2) Will the ATOC project result in reduced disturbance of humpback whales from human-produced underwater noise in Hawaiian waters? Is it compatible with the goal of minimizing human-produced underwater noise in critically important areas such as Hawaiian waters or other winter ranges, as recommended by the Recovery Plan?

III.

Suitability Of Pt. Sur And Kaihu Pt.
For ATOC Sound Transmission

In its evaluation of alternatives, the EIS under preparation by NMFS and the Advanced Research Project Agency ("ARPA") must compare the potential impacts to marine life of the ATOC projects proposed for Kaua'i with a similar project conducted in other areas less rich in marine life.

According to Dr. Roger Payne, President of the Whale Conservation Institute:

> A further consideration makes it seem to me that the choice of both areas [Pt. Sur and Kaihu Pt.] for the broadcast of such intense sounds (lying well within the frequency band which whales can supposedly hear) is ill considered: both are well known areas, not just of the occurrence of whales and other marine mammals, but of their concentration. I believe it might be hard to choose two areas more likely to expose marine mammals to the test signal on such a regular, though unintentional, basis. . . . I would also urge that other areas which do not have such clear concentrations of marine mammals be chosen for the location of the transmitters.

Letter to Carol Fairfield, National Marine Fisheries Service, March 25, 1994.

It is critical that the discussion of alternatives in the EIS explore the feasibility of transmitting the ATOC signal from other locations, and evaluate the number of species and individual animals likely to be exposed and impacted by the signal if it is located in an alternate site.

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IV.

Inadequacy Of The ATOC Marine Mammal Research Program

The ATOC SRP Application P557 indicates that the ATOC Marine Mammal Research Program ("MMRP") will focus on humpback whales, collecting shore-based and aerial visual observations as well as passive acoustic data on this species. In addition, opportunistic visual observations of other marine mammal species and sea turtles will be conducted. It is critical that the ATOC MMRP be comprehensive, well designed and successfully implemented if it is to 1) function as a safeguard that ensures that transmission of the ATOC signal is halted should significant behavioral changes be detected among monitored species; and 2) be used to "make models to predict the effects of man-made noise on marine mammals," as proposed by the ATOC SRP Application (at 11). The EIS must fully consider the concerns raised regarding the adequacy of the MMRP, evaluate alternatives to the proposed design, and assess the capability of the monitoring program to assess impacts on marine life as a result of the ATOC sound source.

The MMRP has been criticized as inadequate in a number of aspects. The criticisms fall into three primary categories: the research program proposes to test an improper hypothesis, and consequently may lead to false conclusions regarding the impacts of the ATOC sound transmissions on marine mammals; the research design is seriously compromised by the requirements of the ocean climate monitoring program, with potentially significant negative impacts on both the research results and the marine mammals under study; and the MMRP is inadequate to detect important short-term behavioral changes in all potentially impacted species.

The first criticism centers on the fact that ATOC proponents have not evaluated the likelihood of failing to reject a false null hypothesis. The research design assumes that the ATOC sound transmissions will have no significant effect on marine mammals (a null hypothesis), and proposes a monitoring program to determine if that hypothesis is accurate (i.e. it will seek to detect significant effects). At no time, however, is the ability of the monitoring program to detect such effects evaluated. The relatively small size of the humpback whale population that is to be monitored (and the even smaller sample size for sea turtles, sperm whales and other species), combined with our lack of knowledge regarding the significance of various behavioral changes exhibited by humpback whales and other marine life in response to noise stimuli, increases the likelihood that the monitoring program will falsely conclude that the ATOC signal has no significant effect.

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This is of particular concern because without statistically significant evidence that ATOC transmissions are causing significant impacts no changes in those transmissions are likely to be made. In addition, this research is intended to be used as a model for the response of marine mammals to low frequency sound, and a false conclusion may have impacts that reach far beyond the ATOC project now under consideration. As a result, it has been suggested that the ATOC MMRP design be reformulated to assume that significant impacts will occur, and that ATOC not be allowed to proceed until that assumption is proven false. See comments to NMFS on SRP Application P557 and P557A by: David Wiley (March 6, 1994) and Kurt Fristrup.

The EIS should fully explore the likelihood that ATOC researchers may fail to reject a false null hypothesis, and consider the impacts that would stem from such a failure. In addition, revision of the research design to assume that significant impacts will occur should be considered.

The second criticism of the research design is that it is compromised by the requirements of the ATOC program, with potentially significant negative impacts on both the MMRP research results and the marine mammals under study. Both the signal strength and playback schedule of the ATOC sound source have been selected in accordance with the needs of the ocean climate modeling project, and not the needs of the marine mammal monitoring program. As Dr. Kurt Fristrup comments:

> The playback schedule itself does not appear to have been selected on biological grounds. It is not explicitly tied to the locations, behaviors, or even the presence of animal groups under observation. It is not clear that the biological researchers will have the authority to initiate transmissions on demand, regulate their level or duration, or indefinitely suspend transmissions to document the restoration of pre-exposure conditions.

Comments to NMFS on SRP Applications P557 and P557A.

This issue is of critical importance for this research project, and also for the precedent that this project could set. "The proposed permit could establish a precedent of allowing "takes" under scientific research permits for any kind of activity as long as marine mammalogists are monitoring it." Peter Tyack, Comments to NMFS on SRP 557A, March 20, 1994.

The EIS must evaluate the viability of the marine mammal research, and consider how that research may be compromised as a result of being conducted in conjunction with the ATOC ocean

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climate program. In addition, a full evaluation of the potential for modification of the ATOC sound source, including variations in signal strength, duty cycle, and frequency levels, and resultant impacts on the ATOC ocean climate program should be included.

The third criticism of the MMRP concerns its ability to detect short-term behavioral changes in all potentially impacted species. A number of specific concerns have been raised with respect to this issue.

First, dedicated monitoring of only one species (the humpback whale) is inadequate to assess impacts on other protected species that are or may be present[1]. The monitoring program should consequently be expanded to include additional marine mammal and sea turtle species. See comments submitted to NMFS regarding SRP 557 and/or 557A by: Scott Benson (March 4, 1994), Linda Weilgart (March 22, 1994), and Hal Whitehead (March 22, 1994).

Second, no monitoring of impacts to non-listed, but nevertheless important species, including fish and invertebrates, is planned, despite the potential for impacts to these species. Such impacts could result in secondary impacts to protected species that are dependent on these as food resources, and economic impacts if ATOC negatively impacts commercially important fish resources. See comments submitted to NMFS regarding SRP P557 and P557A by Jim Darling (March 25, 1994).

Third, the monitoring program is inadequate to detect potentially significant behavioral changes to most species, and only dramatic behavioral changes are likely to be observed. In his comments on the SRPs, Jim Darling notes:

> At best only the most overt impacts on a few species will be recognizable. Even if broader observation regimes could be developed, the natural variability of behavior patterns in most, if not all, species are not

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[1] These species include: sperm whales; pygmy sperm whales; dwarf sperm whales; short-finned pilot whales; Cuvier's beaked whales; Baird's beaked whales; Blainville's beaked whales; killer whales; pygmy killer whales; melon-headed whales; spinner dolphins; spotted dolphins; striped dolphins; false killer whales; rough-toothed dolphins; bottlenose dolphins; monk seals; and loggerhead, green, olive ridley, leatherback, and hawksbill sea turtles.

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well enough known to conclude a change in behavior is the result of the experiment or some other natural variable. Unfortunately, the experiment is far too big in proportion to our impact assessment capability.

Fourth, the MMRP places excessive reliance on acoustic tracking, and should be complement this technique with additional, proven survey methods. Scott Benson, a member of the biological team that participated in the Heard Island Feasibility test in 1991, has commented:

> The biological effect of the sound source should be considered in a thorough manner using proven technology. . . . Innovative use of hydrophone arrays and tracking systems as currently proposed should be complemented with rigorous and ample standard survey techniques in the event that the more modern techniques fail to yield results.
>
> Scott Benson comments to NMFS regarding SRP P557A (March 4, 1994).

The EIS should evaluate these and all other concerns raised regarding the design and implementation of the ATOC MMRP during the EIS scoping and SRP application review process, including comments from the NMFS Southwest Region Office that the marine mammal research is not "bona fide," and the SRP should be denied as a result. _See_ SCLDF April 14, 1994, ATOC SRP comments at 13.

V.

Clarification of Sound Source Control

ATOC researchers indicated during public meetings and SRP hearings held in Hawai'i that the ATOC MMRP results would be constantly evaluated, and sound transmission halted or modified if significant impacts to monitored species were detected. The researchers were unable to definitively state, however, what will constitute a significant impact for purposes of control of the sound transmission. In addition, they suggested that the ATOC MMRP would notify NMFS of impacts to monitored species, and that NMFS would in turn take appropriate action to stop or modify the sound transmission, if warranted. Researchers indicated that at that time (April 16, 1994) protocols for control of the sound source were still being developed.

We are dismayed at the lack of clarity over what constitutes a significant impact, and the lack of protocols for control of

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sound transmission, despite the apparent intention to use MMRP monitoring results to modify or stop sound transmission, if such action is warranted. We also note that the SRP Application P557 makes no mention at any point of sound transmission control or modification as being among the research objectives.

The verbal statements of ATOC researchers are currently the sole indication we have that the ATOC sound transmissions may be influenced by the MMRP monitoring results. It is imperative that the EIS fully discuss this issue, analyzing the ability of the monitoring program to detect impacts, the decision process that will be used to evaluate the significance of any impacts, the protocols that will be established to communicate findings to NMFS and the ATOC ocean climate researchers, and whatever formal agreements will be in place to ensure that protocols are adhered to.

VI.

Evaluation of Cumulative Impacts and Development of Research and Monitoring Protocols for Future ATOC Projects

According to the Acoustic Monitoring of Ocean Climate Phase 2 Proposal Overview (January 16, 1994 at 4), plans are in place for expansion of the ATOC network to the Indian Ocean, southern Atlantic and north Atlantic basins in a phased effort beginning in 1995; an Atlantic ocean experiment to explore acoustic path options is slated for late 1994. These efforts will include significant international participation. Expansion of the ATOC network in this manner has the potential to impact additional species of marine mammals, sea turtles and other marine life, and will greatly increase the number of individuals of any species exposed to the ATOC sound transmissions.

The Kaua'i ATOC project is a key element in the development of the global network, and in the development of "models to predict the effects of man-made noises on marine mammals." ATOC SRP application at 11. If the Kaua'i and California projects prove successful, researchers clearly intend to expand the scope of ATOC. NEPA requires EIS's to consider cumulative actions, "which, when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." 40 C.F.R. § 1508.25 (a)(2).

This is particularly important in light of the fact that, although a hearing on SRP P557A has been scheduled by NMFS, to take place in Santa Cruz, California on May 16, 1994, no commitment has yet been made to prepare an EIS for the California project. That project is very similar to the one slated for

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Kaua'i, both in its design and the potential impacts on marine life; consequently, it is inconceivable to us that NMFS would not require an EIS for the California research permit as well. In addition, Scripp's clear intention to build a global ATOC network, should these early projects prove successful, leaves NMFS little choice but to address the impacts of that larger network at this time.

Consequently, NMFS and ARPA are under an obligation to consider the cumulative impacts of an enlarged, potentially global network in evaluating the impacts of the Kaua'i project. As we explained previously, a programmatic EIS, with "tiered" site-specific EISs (to address Hawai'i, California, and any other future sites) would be particularly appropriate in reviewing the impacts of the ATOC project. See SCLDF April 14, 1994 ATOC SRP comments at 11.

NEPA also requires that EISs include as part of the consideration of alternatives appropriate mitigation measures. § 1502.14. In the case of the ATOC EIS, the mitigation to be considered should include, at a minimum, a comprehensive monitoring program to be conducted in conjunction with, and for the duration of, any ATOC sound transmission. The EIS should also evaluate how that mitigation would be enforced, particularly in the case of ATOC transmitters that are placed in foreign or international waters, and may be funded and/or controlled by foreign governments or research interests.

VII.

Budgeting and Involvement of the Department of Defense

As we indicated in our April 14 comments, the SRPs for the Kaua'i and California projects fail to adequately disclose Department of Defense ("DOD") involvement in the proposed projects. An understanding of the scope and extent of their involvement is critical to the public's review of these research proposals. The EIS must include full disclosure of DOD funding, involvement in decision making, and any plans, committments or discussions that have taken place regarding DOD funding of future ATOC projects, experiments or equipment development. In addition, the EIS should disclose the extent to which ATOC intends to utilize DOD facilities and personnel in the course of the ATOC program.

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Conclusion

We have reviewed the concerns of many organizations and individuals in preparing these comments; collectively, those commenting on these SRP applications have a wealth of experience with marine mammals, sea turtles and other marine life, and environmental protection. We urge you to consider carefully the issues that have been raised, and ensure that the EIS review both reveals and evaluates the extent and nature of the scientific controversies that surround many aspects of the proposed ATOC projects.

Such an evaluation is critically important if informed decisions are to be made regarding the ATOC permit applications, and must include a full review of the impacts associated with a larger ATOC network, and with the California project. The NEPA process is itself expressly intended to "help public officials make decisions that are based on an understanding of environmental consequences, and take actions that protect, restore, and enhance the environment." 40 C.F.R. § 1500.1(c). Accordingly, we view this EIS as only the first step in a comprehensive environmental review that will allow NMFS and the public to fully understand the consequences of the ATOC proposal, and take appropriate actions in response.

We appreciate your careful consideration of the concerns that we and others have raised regarding these projects.

Very truly yours,

Mark Smaalders
Resource Analyst

Denise Antolini
Staff Attorney

cc: Hawai'i Environmental Coalition on ATOC
Dr. David Hyde, Scripps
Hon. Patsy Mink
Hon. Neil Abercrombie
Hon. Sam Farr
Save Our Shores
Hawaiian Islands Humpback Whale National Marine Sanctuary
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AMENDED

April 14, 1994

William W. Fox, Jr.
Director, Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway, Room 13130
Silver Spring, Maryland 20910

Re: ATOC Project, Kaua'i, Hawai'i,
<u>Research Permit Applications P557 & P557A</u>

Dear Mr. Fox:

The Sierra Club Legal Defense Fund ("SCLDF") provides the following comments on the Acoustic Thermometry of Ocean Climate ("ATOC") Project, proposed by the Scripps Institute of Oceanography, Research Permit Applications P557 and P557A, for Kaua'i, Hawai'i and Pt. Sur, California, on behalf of the following organizations: Hawai'i's Thousand Friends, Life of the Land, Sierra Club, Hawai'i Chapter, Animal Rights Hawai'i, Hawai'i Audubon Society, Citizens Against Noise, and Save Our Surf.

INTRODUCTION

Before discussing the unresolved scientific and legal issues surrounding this highly controversial permit application, we wish to register our vigorous protest against NMFS' decision to fast-track the environmental review process. The lack of consultation with the public at an earlier time, the very quick scheduling of hearings, and the recent decision to convert -- at lightning speed -- a draft environmental assessment into an Environmental Impact Statement ("EIS") runs completely contrary to the intent of environmental laws and serves only to heighten public opposition to, and suspicion about, this project.

As you know, SCLDF conveyed to the National Marine Fisheries Service ("NMFS") on March 24, 1994 the request of a dozen Hawai'i environmental organizations for public hearings to be held in Hawai'i on the ATOC permit application. NMFS' decision to hold only one hearing, in Maryland on March 22, 1994, far from the site of the project, was imprudent. While we appreciate NMFS' decision (dated April 1, 1994) to

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grant our request for hearings, we must object to the decision to schedule the two Hawai'i hearings on this complex issue for April 14 and 15, only two weeks after

notice was given. Under NMFS' regulations, notice must be published "no less than 15 days in advance of the hearing." 50 C.F.R. § 216.33(b). Thus, the public notice of these meetings is patently defective.

The environmental groups in Hawai'i concerned about this issue, as well as the hundreds of individuals who made their objections known to NMFS, have simply not had sufficient time to prepare for today's hearing. The scientific issues are complex and the experts far-flung. Thus, we request that more public hearings be held on O'ahu and on Kaua'i after the draft EIS issues to allow the public sufficient time to engage in an intelligent dialogue with the appropriate agencies on this very important issue.

Moreover, the decision to push forward with the Hawai'i hearings and, at the same time, postpone the California hearings suggests a double-standard is being applied and operates to frustrate genuine public participation in this process. The environmental community in Hawai'i is deeply concerned that Kaua'i is being used as the "guinea pig" for ATOC, which would be completely inappropriate and be vigorously opposed.

NMFS' decision only two days ago, on April 12, 1994, to have these hearings also serve as "scoping" hearings for purposes of preparation of an Environmental Impact Statement ("EIS") by NMFS and the Advanced Research Projects Agency ("ARPA") of the U.S. Department of Defense ("DOD") under the National Environmental Policy Act ("NEPA") further points to the conclusion that this project is being rushed headlong through the public review process. Why the rush?

As part of the scoping process, NMFS and ARPA must clearly indicate the relationship between the timing of the preparation of the environmental analyses and the agency's planning and decisionmaking schedule. 40 C.F.R. § 1501.7(a)(7). This is particularly important with respect to the relationship between the Kaua'i project and the Pt. Sur project. This has not been done.

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Under NMFS' regulations, a final decision on the permit must be made within 30 days after the close of any public hearing. 50 C.F.R. § 216.33(c). How does NMFS plan to reconcile this requirement with the decision to prepare an EIS that may take several months? Under the circumstances, the only rational decision can be to deny the permit.

Ultimately, the decision to rush the deliberations -- regardless of whether it is intentional or not, or budget-driven or not -- does a grave dis-service not only to the public, but also to the project itself. If the ATOC project is, as Scripps claims, a valuable new scientific method to study global climate change, and if the marine mammal research project is, as the marine mammalogists working with Scripps claim, completely benign, then the public disclosure and deliberation process will engender public support and work to the long-term advantage of the project proponents.

Even NMFS and Scripps should agree that the utmost caution should be used in starting a project that has unknown consequences on marine species that have the highest levels of protection afforded by our nation's environmental laws. The ATOC project must be put on hold while the environmental review process is followed to the fullest extent possible. Only then will be public be satisfied that these precious marine species -- who cannot speak for themselves -- are not being put at risk in the name of science.

I.

BACKGROUND: THE PERMIT APPLICATION

According to NMFS' and ARPA's April 12, 1994 notice of intent to prepare an EIS, Scripps Institute of Oceanography, Institute for Geophysics and Planetary Physics, Acoustic Thermometry of Ocean Climate ("ATOC") Program is requesting authorization to "take" by harassment several species of cetaceans, including humpback whales, Hawaiian monk seals, and sea turtles in Hawaiian waters near Hanalei, Kaua'i.

The October 25, 1993 permit application to NMFS for a Scientific Research Permit ("SCP") under the Marine Mammal Protection Act ("MMPA") provides a limited description of the project background. Scripps is undertaking a federally sponsored, international research initiative to measure long-term ocean climate changes on global scales using deep ocean acoustic sound paths to measure ocean temperatures. Scripps proposes to install two acoustic transmitters and a series of receivers throughout the Pacific over a two-year period (1994-1995) to

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assess the feasibility of a broader global ocean climate monitoring program.

The source transmitter near Kaua'i would be located at 850-950 meters depth, 13.7 miles north of Kaihu Point. Scripps proposes to transmit a low frequency signal centered at 70 Hz, with a bandwidth of 20 Hz and a band level of 195dB re 1 uPa. During "normal" operations, the transmissions would last 20 minutes and be repeated every four hours at a maximum rate of 6/day (8% duty cycle).

The environmental community in Hawai'i has not been provided with copies of Scripps' permit application for the Pt. Sur project and thus we cannot adequately describe it here. We request that copies of this application immediately be made available to all interested parties in Hawai'i at no charge.

II.

NUMEROUS SCIENTIFIC ISSUES REMAIN UNRESOLVED

Scripps' SCP does not adequately discuss the numerous unresolved scientific issues related to this project, both in terms of global climate change research and the potentially affected species.

The highly controversial nature of the scientific issues related to this project were emphasized in a recently issued statement joined by fifteen prominent scientists (letter attached), who concluded that:

> information on the hearing sensitivities and on the diving abilities of most marine mammals is limited, and that we do not yet know what the subtle, long-term effects of noise on marine mammals might be. Given these uncertainties, we do not feel that it is prudent to proceed at this time with the ATOC experiment.

We concur in this analysis and recommendation, and urge NMFS to consider it carefully.

A. Global Climate Change Research

Significant controversy exists regarding the measurement of global ocean temperature through the ATOC project. Experts have questioned the project on three primary grounds:

(1) Can meaningful information regarding ocean temperature be obtained?

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(2) Will that information lead to significantly better understanding of global climate change, and the causes of that change?

(3) Will such an understanding lead to corrective actions on the part of nations and individuals?

The potential impacts of the ATOC project, as well as the significant expense, require a full and critical evaluation of its purported benefits. A comprehensive analysis must include alternative methods by which the temperature data can be collected.

B. <u>Extent of the ATOC Zone of Influence</u>

The estimates provided in the Scripps' SPC application of the ATOC Zone of Influence ("ZOI") are based on the assumption that no significant impacts to marine life will occur at sound levels below 120-130 dB. Other scientists have questioned this assumption, however, suggesting that some species may be impacted at 110 dB levels. In addition, researchers are concerned that the ATOC sound source may interfere with the ability of whales to detect the songs of other whales, due to the increase in the ambient noise levels. The ZOI for such "noise pollution" extends far beyond the 40 km stated in the permit application, and possibly as far as 1,300 km. The EIS must examine <u>all</u> impacts related to the ATOC sound source, and reconsider the ZOI, and the potentially impacted marine life.

C. <u>Impacts on Marine Life</u>

The EIS must address the potential impacts of the ATOC sound source on <u>all</u> marine life, including species not addressed in Scripps' SCP application. The EIS must particularly address potential impacts to species listed as threatened and endangered under the Endangered Species Act, and to species which may serve as critical food sources for those threatened and endangered species.

1. <u>Sea Turtles</u>

The following species of sea turtles are found in waters adjacent to the Hawaiian Islands: green, hawksbill, leatherback, loggerhead and olive ridley sea turtles. The green and leatherback sea turtles are most likely to be encountered in the waters off Kaua'i. Available research (<u>see</u> Balazs and Ross, 1974; O'Hara and Wilcox, 1990, Lenhardt et al 1983; and Ridgway et al 1969) indicates that sea turtles <u>do</u> respond to low frequency noise. It is therefore imperative that a full analysis

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of the potential impacts of the ATOC sound source on sea turtles be conducted.

Sea turtle researchers (including members of the NOAA/NMFS Pacific Basin Sea Turtle Recovery Team) have indicated that the monitoring proposed in Scripps' SCP permit application will not be sufficiently sensitive to detect potentially significant behavioral changes, which may impact sea turtle populations, and ultimately sea turtle recovery. The National Marine Fisheries Service, Office of Protected Resources, Permits Division, has raised these concerns as well (see attached April 12, 1994 letter from Ms. Ann Terbush to Dr. Christopher Clark), stating:

> We strongly recommend that you develop a more comprehensive research program to determine the behavioral and physiological effects of the ATOC project on sea turtles.

In its evaluation of impacts to sea turtles, the EIS must consider preliminary studies, to be performed before the ATOC sound source begins transmission. These studies would include captive studies of sea turtle response to low frequency sound, and satellite tracking of turtles (particularly resident green turtles) in their migrations between the Northwestern and main Hawaiian Islands. Such studies would allow an informed decision regarding probable impacts on sea turtles to be made; it would also provide a baseline of data (from satellite tracking) that could be used to measure impacts from the ATOC sound source, if the decision to proceed with the project was made.

2. Fish And Invertebrates

According to the recently released study "Low-Frequency Sound and Marine Mammals - Current Knowledge and Research Needs," conducted by the Committee on Low-Frequency Sound and Marine Mammals, the Ocean Studies Board, and the Commission on Geosciences, Environment, and Resources of the Nationalo Research Council (hereinafter NRC Marine Mammal Study) (at 53),

> Sound is important for normal behavior of many species of bony and cartilaginous fishes . . . Fish use sound for a variety of reasons, including but not limited to prey detection, intraspecies communication, maintenance of schools, and predator avoidance.

Recent research indicates that low frequency sounds are also associated with fish reproductive behavior (see, for example Lobel 1992). The ear and lateral line organs, which detect acoustic and hydrodynamic signals, are thus very important to normal fish behavior, and "damage to these systems would severely

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affect [the fishes] ability to survive and reproduce." NRC Marine Mammal Study, at 53.

Although little is known about the use of sound by marine invertebrates, at least some species are known to have highly developed systems for detection of sound.

Impacts on fish and invertebrates may be significant both ecologically and economically. If ATOC negatively impacts fish and invertebrate populations, secondary impacts may also be felt along the marine food chain, as reductions in invertebrates or fish may deprive marine mammals and other higher-level predators of important food sources. Reductions in fish populations may also have economic impacts, as there are many economically important fish species (including some that are deep-dwelling) found in Hawaiian waters.

It is imperative that the EIS examine potential impacts to fish and invertebrates. Because of the lack of data on fish and invertebrate response to sound sources, the EIS must also consider preliminary studies, to be performed <u>before</u> the ATOC sound source begins transmission, which could form the basis for an informed decision on whether to proceed with the project, as well as providing prior baseline data, should the ATOC project proceed.

3. Lack of Knowledge Regarding Impacts Of Low <u>Frequency Sound On Marine Mammals</u>

A fundamental issue of concern that must be addressed in the EIS is our lack of knowledge about the impacts of low-frequency sounds on marine mammals. The NRC Marine Mammal Study states (at 1):

> Data on the effects of low frequency sounds on marine mammals are scarce. Although we do have some knowledge about the behavior and reactions of certain marine mammals in response to sound, as well as about the hearing capabilities of a few species, the data are extremely limited <u>and cannot constitute the basis for informed prediction or evaluation of the effects of intense low-frequency sounds on any marine species.</u>

The SCP application submitted by Scripps for the ATOC project also acknowledges the lack of information and knowledge, stating (at 9):

> The marine mammal research proposed here is motivated by the fact that we do not yet know enough about the impact of the ATOC source on marine mammals to predict levels, areas, and

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scales of influence. Previous studies of marine mammal responses to man-made noises have examined short-term behavioral responses to broadband industrial and recreational vessel noise and there are no data on the potential effects of a sound with ATOC source characteristics.

In light of the lack of data on impacts to marine mammals, it is critical to analyze fully the potential impacts prior to initiating the ATOC project. This is particularly important for several reasons:

a. ATOC is ultimately slated to be global in scope, with 10 or more sound transmitters, possibly operating for decades. The deep waters of the much of the world's oceans will be subjected to low frequency sound transmissions generated by ATOC. The potential impacts on marine mammal, turtle and fish populations are thus much greater than those being discussed for this initial project off the coast of Kaua'i.

b. The long-term monitoring effort will require hundreds of millions of dollars, and will involve researchers and agencies from a number of countries. Once begun, it will be very difficult to change the course of this massive effort, and even more difficult to halt it, even if data showing significant impacts on marine life are reported. The appropriate time to evaluate potential impacts is now, before the project is approved and begun.

c. The most significant potential impacts to marine life from the ATOC project are likely to be at the population level, in the form of reduced breeding success, and impaired communication, feeding, or other behavior that is critical to individual and population survival. Despite their importance, however, these population level impacts admittedly will not be monitored in the course of the Kauai ATOC project:

> It is the intent of this program to determine whether significant or permanent impacts are possible on humpbacks, but at this time the research is designed to detect short-term changes in response to the ATOC source. (Scripps' SCP Application, at 23)

The ATOC project has focused on short-term behavioral shifts, despite the fact that these are not good indicators of long-term impacts:

> While short term, surface-based measurements of changes in direction associated with received noise level provide good indication of startle response or transitory avoidance, they

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> are unreliable for estimating long-term changes (e.g., increased activity, avoidance of critical habitat, interruption of feeding, or failure to find a mate) that could have significant biological consequences. (Id. at 9)

It is critical that a more complete understanding of the linkages between short-term behavioral changes and long-term population level impacts be understood prior to initiating a long-term project.

d. In its focus on humpback whales, the ATOC monitoring effort is not examining those marine mammal species that may be most likely to be impacted by the sound source. Sperm whales, which are known to hear sounds in the 70 Hz range and are deep diving (to and exceeding 1000m) will not be systematically studied in the waters off Kauai:

> There is no specific attempt in this program to systematically describe and compare the behaviors of sperm whales before, during, and after the ATOC source . . . (Id. at 23)

In addition, the ATOC project has made no commitment to studying the potential impacts of the ATOC sound source on other species of marine mammals, such as may be found off California or other future ATOC sound source sites. If the humpback is to be used as the indicator species for the ATOC project, the similarities between humpback response (at both the individual and population level) with other potentially impacted marine mammals must be fully analyzed. If the humpback is not an appropriate indicator species, or if insufficient data exists to support a conclusion, then monitoring studies should be expanded to include additional potentially impacted species.

III.

FULL COMPLIANCE WITH THE ENVIRONMENTAL LAWS IS REQUIRED BEFORE THE ATOC PROJECT CAN PROCEED

In addition to the numerous scientific issues that have been raised and stand unresolved, there are an array of legal issues that deeply concern us. Our review of the environmental laws that are implicated by the ATOC project confirm, again, the conclusion that there has been wholly insufficient agency review of the potential environmental impacts of this project and that the applications may conflict directly with the laws protecting marine mammals and listed threatened and endangered species.

A. A Full And Adequate EIS Under NEPA Must Be Prepared

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NMFS has recently determined that an EIS will be prepared for the ATOC-Kaua'i project. (Notice of April 12, 1994.) According to that notice, the EIS will consider: (1) the potential effects of the proposed low frequency sound source on marine mammals, sea turtles, and other marine resources, including fish; (2) alternatives with respect to site selection; and (3) the purpose of the ATOC program and an evaluation thereof as compared to other possible alternatives for assessing global warming.

We are pleased that NMFS and ARPA will be preparing an EIS for this project. As indicated in the attached March 17, 1994 letter from the Natural Resources Defense Council ("NRDC") to NMFS, there can be little doubt that it is a major federal action that may significantly affect the quality of the environment as contemplated by NEPA. 42 U.S.C. § 4332(C).

However, we are gravely concerned about the following issues:

First, the EIS process is being unduly rushed. As stated above, notice of scoping was only recently issued. According to the regulations of the Council on Environmental Quality ("CEQ"), EISs (where appropriate) "shall be commenced no later than immediately after the application is received." 40 C.F.R. § 1502.5. In this case, <u>nearly six months passed</u> between NMFS' receipt of the application for a scientific research permit and the decision to prepare an EIS.

Now, NMFS and ARPA appear to be in quite a hurry to convert the draft EA (which has never been released to the public) into an EIS. This last-minute review is inconsistent with NEPA and the CEQ regulations.

Second, according to the Scripps' scientists, the EIS is being done "voluntarily." This interpretation of the law is incorrect. NMFS and ARPA should make clear to Scripps that the EIS is being <u>required</u> by NEPA. Otherwise, the project proponent may later decline to fulfill all of NEPA's requirements and spark unnecessary controversy, if not litigation.

Third, NMFS and ARPA appear to be improperly limiting the scope of the EIS to the Kaua'i portion of the ATOC project. Under the CEQ regulations, proposals that are "related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement." 40 C.F.R. § 1502.4.

Moreover, the regulations require that a "programmatic" EIS may be required for broad federal actions that have common

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timing, impacts, alternatives, methods of implementation, media or subject matter. 40 C.F.R. § 1502.4(c).

Indeed, the regulations specifically recommend preparing a programmatic EIS for "federally assisted research, development or demonstration programs for new technologies which, if applied, could significantly affect the human environment." Id., § 1502.4(c)(2).

For such large-scale technology programs,

> Statements shall be prepared . . . and shall be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

Id., § 1502.4(c)(3). See also id., § 1502.20.

A programmatic EIS, with "tiered" site-specific EISs, would be particularly appropriate here where NMFS has received at least one other similar permit application from the same project proponent (for an ATOC transmitter at Pt. Sur, Monterey Bay, California) and others are under consideration around the globe (including the Indian and southern Atlantic Oceans).

Fourth, it does not appear that Scripps is genuinely interested in exploring alternatives to either the proposed marine mammal research program, or, as suggested in the hearing notice, to the ATOC project itself. A full "alternatives" analysis is, of course, the "heart of the environmental impact statement." Id., § 1502.14. The analysis should "sharpen the issues" and provide a "clear basis for choice among options by the decisionmaker and the public." Id. (emphasis added). All reasonable alternatives must be explored in detail so that reviewers may evaluate their comparative merits.

Fifth, the EIS must discuss the possible conflicts of the ATOC project with the objectives of federal, regional, state and local land use plans, policies and controls. 40 C.F.R. § 1502.16(c). With respect to the Kaua'i ATOC project, the EIS must carefully consider the implications for the recently designated Hawaiian Islands Humpbacks Whale National Marine Sanctuary ("HIHWNMS"). We understand the area in which the project is proposed is under active consideration for inclusion in the HIHWNMS. The project may deteriorate the quality of the area to the extent that it might be excluded from the sanctuary because it may directly conflict with the purpose and intent of the sanctuary program.

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Sixth, the EIS must clearly identify the factual areas where there is "incomplete" or "unavailable" information. Id., § 1502.22. Furthermore, on many of the issues raised about this project, the answer of "no information exists" will not be adequate. The agencies and applicant must undertake necessary measures to obtain that information. Id., § 1502.22 (incomplete information that is essential to evaluation must be obtained if the costs are not exorbitant). If the costs of obtaining the information is excessive, then the EIS must explain the relevance of the incomplete information, summarize existing credible scientific evidence on the issue, and evaluate impacts using theoretical approaches or research methods that are generally accepted in the scientific community. Id.

Seventh, we are concerned that the applicant may attempt to move ahead with the project while the EIS process is underway. The October 1993 SCP indicated that the Kaua'i ATOC project was originally projected to be in place beginning after February 1, 1994, almost two months ago, and we are aware that the equipment for the project has arrived in Hawai'i. We are also aware that the funding for the project has a 30-month term. These circumstances lead us to conclude that, but for the EIS process and public pressure, the Kaua'i-ATOC project would have been already commenced.

NEPA prohibits the irrevocable commitment of resources to a project prior to the completion of the EIS process. Until a Record of Decision ("ROD") issues, no action may be taken that would have an adverse environmental impact or would limit the choice of reasonable alternatives to the project. 40 C.F.R. § 1506.1. Where the application is from a non-federal entity, it is the agency's responsibility to ensure that the applicant understands this directive of NEPA. Id.

We request that all of these issues be addressed in the Draft EIS and be taken into consideration in NMFS' review of the SRP.

B. NMFS And ARPA Must Conduct An Analysis Of Project Alternatives Under Section 102(2)(E) of NEPA

In a March 17, 1994 letter to NMFS (attached hereto), NRDC explains the basis for its request than a Section 102(2)(E) "alternatives analysis" be prepared for the ATOC project because it presents "unresolved conflicts as to the proper use of resources." SCLDF concurs in this request, and urges NMFS and ARPA to proceed immediately to commence that process. The status of the alternatives statement should be discussed in the Draft EIS.

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C. The Permit Application Does Not Appear To Satisfy The Strict Criteria Of The Marine Mammal Protection Act

As explained in the April 8, 1994 comments submitted to NMFS by Heller, Ehrman White & McAuliffe on behalf of NRDC (attached hereto), the proposed ATOC project does not appear to meet the criteria for a scientific research permit under the MMPA. Under 16 U.S.C. § 1371(a)(i), a scientific research permit can be issued only where the taking "is consistent with the purposes and policies" of the MMPA. In addition, the permit must be for bona fide and necessary or desirable scientific purpose, taking into account the benefits anticipated to be derived from the scientific research contemplated and the effect of the proposed taking on the population stock and marine ecosystem. 50 C.F.R. § 216.31(c).

According to a December 21, 1993 internal memorandum, the Southwest Region of NMFS has recommended that the Scripps scientific research permit be denied because "the proposed research is not 'bona fide.'" (Memorandum attached hereto.) The Southwest Region recommended that a "more appropriate mechanism" to authorize the requested activity would be a "small take" exemption under section 101(a)(5) of the MMPA and an Incidental Take Statement under Section 7 of the ESA. The recommendation of the Southwest Region is that:

> the ATOC testing be postponed for at least one year during which additional baseline information may be collected and monitoring methods re-evaluated so that any effects on these species from the sound source can be detected. This would allow time for development and processing of a 101(a)(5) incidental take authorization, including requirements for monitoring, that would sufficiently evaluate the impact of the acoustic sound on marine mammals and turtles.

Id. at 2.

Under the "small takes" regulations, 50 C.F.R. Part 228, a proper request for such a take must be made and information submitted in eleven separate categories, including: the anticipated impact of the activity on the species and their habitat; the anticipated impact of the habitat loss on the populations as a whole; the availability and feasibility of equipment, methods, and manner of conducting such activity and other means of effecting the least practicable adverse impact on the affected species, paying particular attention to rookeries, mating grounds, and areas of similar significance; and a monitoring and evaluation plan.

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Moreover, it appears that the applicant may have to apply for an incidental take permit under Section 10(a)(1)(B) of the ESA. Under 50 C.F.R. § 222.22, NMFS may issue permits to take endangered marine species incidentally to an otherwise lawful activity under section 10(a)(1)(B) of the Endangered Species Act. As part of that application, the proponent must include a conservation plan, based on the best scientific and commercial data available, which specifies the anticipated impact, the likelihood of restoration of the affected habitat, the monitoring and mitigation plan, and the funding available to implement such measures, as well as the alternative actions to such taking that were considered and the reasons why those alternatives are not being used. Id.

To the best of our knowledge, neither ARPA nor Scripps has applied for an incidental take permit or a "small takes" permit for the Kaua'i-ATOC project. While we do not have sufficient information about the project at this time to conclude which type of permit may be appropriate, there are at least serious questions remaining about whether the applicant has even applied for the proper permit.

D. NMFS And ARPA Must Initiate And Complete Formal Consultation Under Section 7 Of The Endangered Species Act

Under Section 7 of the Endangered Species Act, agencies proposing actions that may adversely affect listed species or their habitat must initiate a consultation process. NMFS was notified of this legal requirement by NRDC by letter dated April 3, 1994 (attached).

If listed species occur in the area of the proposed project, a Biological Assessment ("BA") must be prepared. If the BA indicates that formal consultation is required, then a formal Biological Opinion ("BO") must be formulated.

We are not aware that either NMFS or ARPA has initiated or completed the consultation process. The EIS must disclose and discuss the status of consultation and the agency's timetable for completing that process.

E. The ATOC Project Conflicts With The Goals And Possible Future Boundaries Of The Hawaii Islands Humpback National Marine Sanctuary

As explained in the April 8, 1994 letter from Heller Ehrman to NMFS (attached), the ATOC project appears to conflict with the Marine Protection, Research and Sanctuaries Act, 16 U.S.C. § 1431(b)(1). The Pt. Sur portion of the project is located

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within the Monterey Bay National Marine Sanctuary, and the Kaua'i project is in an area that is under active consideration for inclusion in the new Hawaiian Islands Humpback Whale National Marine Sanctuary. These issues must be addressed thoroughly in the EIS.

IV.

BUDGETING AND INVOLVEMENT OF THE DEPARTMENT OF DEFENSE

The SCP application does not adequately disclose the involvement of the Department of Defense and/or ARPA in the proposed project.

The Draft EIS must disclose this information, including budgetary information that may assist the public and decisionmakers in determining the need for the project, as well as related actions.

CONCLUSION

In conclusion, we have many serious concerns not only about the important and controversial scientific issues swirling around Scripps' permit application, but also whether, how, and when this project will comply with the host of important environmental laws that protect the species at risk.

Please consider these comments as a request to stay all processing of the Scientific Research Permit until a full and adequate EIS is prepared. These comments should also be considered "scoping" comments pursuant to the April 12, 1994 notice of intent to prepare an EIS. You should be aware that the organizations named above that are being represented by SCLDF for purposes of these comments may also be submitting their own supplemental comments and testimony, and that SCLDF may submit additional testimony based on the public hearings.

We also formally request that ten copies of the Draft EIS be provided to us for immediately upon publication so that we may distribute them to the above-identified Hawai'i environmental groups concerned about this matter.

Finally, we request that additional public hearings be held in Hawai'i -- on O'ahu and on Kaua'i -- no earlier than 30 days (instead of only 15 days) after the Draft EIS has issued and at least one week prior to the close of the required 45-day public comment period. Under the NEPA regulations, public participation is strongly encouraged, and public hearings should be held where there is substantial environmental controversy concerned the proposed project or substantial interest in holding the hearing.

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There is little doubt that the Kaua'i-ATOC project meets these criteria for holding additional public hearings.

We appreciate NMFS' careful deliberation on this important permit application.

Very truly yours,

Denise E. Antolini
Staff Attorney

Mark Smaalders
Resource Analyst

Enclosures
cc: Hawai'i Environmental Coalition On ATOC .

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SAVE THE HUMANS

Center for World Peace, Waialua, Molokai 96748 Ph: 558-8923

Ann Terbush
Chief, Permits Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

April 14, 1994

Dear Dr. Terbush:

I am writing to urge you, in the strongest possible terms, to deny scientific research permits Nos. P557 and P557A, on the grounds that they could conceivably threaten the extinction of the Humpback whales of Hawaii.

As the Hawaiian Islands Humpback Whale National Marine Sanctuary points out: "reduced to approximately 1,000 animals from the pre-whaling numbers of about 15,000, the North Pacific humpback populations have been estimated recently at between 1,500 to 3,000 animals. The humpback whale will not be considered by NOAA's National Marine Service (NMFS) recovered under the Endangered Species Act of 1973, as amended (ESA), until it reaches 60 percent of the prewhaling population (i.e., 9,000 animals)." (Discussion Paper for the Development of a Draft Environmental Impact Statement and Sanctuary Management Plan, Honolulu: U.S. Department of Commerce, National Oceanic and Atmospheric Administration and Office of the Governor, Office of State Planning, 1994, p. 15)

The humpbacks are an endangered species, who are protected by law reflecting the will of the people, and it is the job of the Office of Protected Resources among other agencies to protect them. Please do so.

It is also the job of the Hawaiian Islands Humpback Whale National Marine Sanctuary (whose Advisory Board I am asking to join). As they point out, "the Oceans Act of 1992 (The Act) simultaneously designated the Sanctuary and reauthorized and amended Title III of the MPRSA. According to the Act, the purposes of the Sanctuary are:

(1) to protect humpback whales and their habitat in the area described...
(2) to educate and interpret for 1the public the relationship of humpback whales to the Hawaiian Islands marine environment;
(3) to manage such human uses of the Sanctuary consistent

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this subtitle and Title III of the MPRSA as amended by this Act... (Discussion Paper, p. 4)

The Humpbacks' habitat in the area described includes the waters off Kilauea National Wildlife Refuge on the island of Kauai, and the 1993 Aerial Survey they cite, done by Mobley, et. al., shows that many pods winter in those waters (Discussion Paper, Appendix B). Now, as I read p. 4b of ATOC's Marine Mammal Research Program's application, all of those protected waters off Kauai apparently will be within the projected Zone of Influence, i.e., area of admitted "Acoustic Harassment." So? As I read Table 1 of the application, Dr. Clark and his colleagues estimate that in the two years of the permit, they will "take" approximately 1,700 humpback whales (p. 6a). I commend their honesty, but I wish they had reminded the reader that this is the <u>entire</u> Hump-back population of the North Pacific!

So what, you say? Well, according to the ATOC application, "the most probable detectable effects on free-ranging marine mammals as a result of the scheduled ATOC transmissions off Kauai are disturbance-induced changes in: 1) distribution and relative abundance around the source, 2) behavioral and social activity patterns, and 3) sound production."

All of this is illegal and -I will argue- immoral, but what appears to most directly threaten the extinction of the humpbacks is the probable effect on sound production. As the Hawaiian Islands Humpback Whale National Marine Sanctuary points out: "Male humpbacks are the singers. Their long and complex sounds called songs are used to 'advertise' their virility and attract receptive females for breeding purposes." (Discussion Paper, p. 16)

Dr. Walter Munk of the ATOC team has publicly complained of poor and inaccurate reporting by the press, particularly the Los Angeles Times, so I took the opportunity in Honolulu on April 5th to ask his colleague Dr. David Hyde, the Project Director, if he was quoted correctly on p. A30 of the Los Angeles Times of March 26th, as follows: "We're not out to harm a single animal and we will stop the project if there is any evidence of that..." He said, "yes, that is correct." I then asked him what he meant by "harm" and "stop." I was not satisfied by his answer then, and I am even less satisfied after -finally- getting a chance to read the ATOC application.

Dr. Hyde never really said what he meant by "harm" and now I have read that the "probable detectable effects" include reduction in "sound production," with its implications for the future of the species. And he said what "stop" meant was "stopping the sound projection" of the ATOC underwater speaker. That is not enough.

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We should stop the sound projection of the ATOC underwater speaker before it starts, unless there are iron-clad guarantees (the kind that don't exist in the world of science) that not a single humpback will be harmed at all. As Dr. Clark and his colleagues admit on p. 23 of the ATOC application, "nothing is known about temporary shifts in hearing of marine mammals."

We, the people of Hawaii and the people of the United States, should use the Hawaiian Islands Humpback Whale National Marine Sanctuary and the Permits Division of the Office of Protected Resources to repay our moral debt to the species we decimated by protecting them.

That is what the law requires. More importantly, that is the right thing to do.

Kala mai. Forgive me, if I have offended you. But this mana'o I share is what my heart tells me.

Aloha! and Malama Pono!

Claud Sutcliffe, Ph.D.
Center for World Peace
Waialua, Molokai, Hawaii

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April 8, 1994

VIA FEDERAL EXPRESS

Mr. Rolland A. Schmitten
Ms. Anne Turbush
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
1315 East-West Highway
Silver Springs, MD 20910

Mr. Jim McCallum
National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii 96822

Re: Comments on Application for Scientific Research Permits (P557 and P557A) to Take Marine Mammals and Other Species -- Acoustic Thermometry of Ocean Climate Program ("ATOC")/Pt. Sur, California and Kauai, Hawaii

Dear Messrs. Schmitten and McCallum and Ms. Turbush:

The Acoustic Thermometry of Ocean Climate Program ("ATOC") of the Scripps Institution in La Jolla, California ("Scripps"), has submitted two scientific research permit applications (numbered P557 and P557A) to the National Marine Fisheries Services ("NMFS"). ATOC proposes to place two underwater acoustic transmitters on the sea floor, one in the Monterey Bay National Marine Sanctuary off the coast of California and the other off of Kauai in areas under consideration for inclusion in the Hawaiian Islands Humpback Whale National Marine Sanctuary. These transmitters would emit low frequency sound signals at approximately 190 decibels for twenty minutes every four hours for at least the next two years. Because this project would harass a wide range of marine mammals protected by the Marine Mammal Protection Act of 1972 ("MMPA"), Scripps is seeking taking permits under the MMPA to allow it to proceed. We write on behalf of the Natural Resources Defense Council ("NRDC") whose staff and members

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study and enjoy the unique, diverse and beautiful marine environs of the state of Hawaii and the island of Kauai. These comments should also be placed in the record with respect to the Monterey Bay project, and NRDC's earlier written comments dated March 3 and March 17, 1994 should be incorporated into the record with respect to the Kauai program. In addition to its previously expressed concerns regarding proper compliance with the National Environmental Policy and the Endangered Species Acts, NRDC below describes its concerns regarding the ATOC permit applications under the MMPA and the Marine Protection, Research, and Sanctuaries Act of 1972.

Marine Mammal Protection Act of 1972

Congress enacted the MMPA to protect all mammals who spend all or part of their lives in the sea from the adverse effects of man's actions, 16 U.S.C. § 1361, and the centerpiece of this legislation is a moratorium on the taking of marine mammals. 16 U.S.C. § 1371(a). The MMPA defines "taking" to include not only capturing or killing marine mammals, but also harassing or attempting to harass these animals. 16 U.S.C. § 1362(13). Congress intended the concept of harassment to be construed broadly to include, for example, the excessive or wanton use of herbicides which drain into waterways destroying marine mammal habitat, and the improper operation of powerboats. H.R. 92-707, Dec. 4, 1971, 1972 U.S.C.C.A.N. 4150. In subsequent amendments to the MMPA, Congress also specifically evinced a concern about acoustic harassment of marine mammals. See H. Rep. No. 100-970, 1988 U.S.C.C.A.N. 6164.

The MMPA provides only limited exceptions to this moratorium on the taking of marine mammals. See 16 U.S.C. § 1371. The only exception arguably relevant to the ATOC project is permitted taking for purposes of scientific research. Scientific research permits, however, are available only under limited circumstances, and only if the taking "is consistent with the purposes and policies" of the MMPA. 16 U.S.C. § 1371(a)(1). The "basic underlying theme" of the MMPA is that any taking that occurs must "not occur to the disadvantage of the species or stocks from which the animals are taken...[The MMPA] requires, in effect, that limitations be established which will be designed to act for the benefit of the animals in question." 1972 U.S.C.C.A.N. 4157. See also 16 U.S.C. § 1373(a). Thus, our view is that a permit for taking incidental to scientific research may be obtained, but only if that research will benefit the animals being taken.

The requirement that the proposed scientific research be consistent with the purposes of the MMPA is also contained in the regulations promulgated under the MMPA, which require that the

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following criteria be considered in determining whether to issue a scientific research permit:

(1) whether the proposed taking will be consistent with the policies and purposes of the MMPA, and

(2) "whether the granting of the permit is required to further a bona fide and necessary or desirable purpose, taking into account the benefits anticipated to be derived from the scientific research contemplated and the effect of the proposed taking...on the population stock and the marine ecosystem."

50 C.F.R. § 216.31(c) (for whales, dolphins and seals); 50 C.F.R. § 18.31(c) (for sea otters).

We are concerned that the ATOC project does not appear to be consistent with the purposes of the MMPA.[1] There is no indication in the permit of how it would be beneficial to the marine mammals to be taken to be subjected to the sound transmissions, whether as individuals or as a species, even though the burden is on the applicant for the permit to show that the taking of a marine mammal under the permit will be consistent with the purposes of the MMPA and regulations promulgated under it. 16 U.S.C. § 1674(d)(3), 72 U.S.C.C.A.N. 4158. The MMPA does not countenance approving permits for scientific research on a simple "knowledge for the sake of knowledge" rationale -- the research in question must benefit the marine mammals themselves. Even were the MMPA to be interpreted to allow experimentation for purposes other than to benefit marine mammals, such research certainly must employ those methods least harmful to such marine mammals. Plainly, there are prudent scientific methods available to monitor global temperature trends which do not involve the use of sounds so invasive to marine life.

1 We also note that no "depleted" species of marine mammal may be killed as part of a research project unless "the results of such research will directly benefit that species or stock, or that such research fulfills a critically important research need." Id. We do not believe that it is "critically important" to monitor warming trends using the ATOC proposal and are fearful that the assault of sound contemplated by the ATOC project may impair the senses upon which many depleted species of marine mammals depend to survive.

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Marine Protection, Research, and Sanctuaries Act of 1972

The Marine Protection, Research and Sanctuaries Act of 1972 ("Marine Sanctuaries Act") has as a primary purpose the identification and designation of "areas of the marine environment which are of special national significance." 16 U.S.C. § 1431(b)(1). The sanctuaries are intended "to maintain, restore, and enhance living resources by providing places for species that depend upon these marine areas to survive and propagate." 16 U.S.C. § 1431(b)(9). The ATOC project is located in the Monterey Bay National Marine Sanctuary (the "Monterey Bay Sanctuary"), which stretches along the coast of central California, See 15 C.F.R. Part 944, and is also located in one of the most pristine and beautiful areas in the world off of Kauai, currently under consideration for inclusion in the Hawaiian Islands Humpback Whale National Marine Sanctuary.

An important feature of the Marine Sanctuaries Act is the protection afforded to "sanctuary resources." The Act defines "sanctuary resources" to include "any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, research, educational, or aesthetic value of the sanctuary." 16 U.S.C. § 1432(8). The Act prohibits destroying, causing the loss of, or injuring any sanctuary resource managed under law or regulations for a sanctuary, 16 U.S.C. § 1436(1), and requires that the Secretary of Commerce be consulted regarding any permitted activity that is <u>likely</u> to have such a deleterious effect. 16 U.S.C. § 1434(d)(1)(A). The federal agency proposing to allow such an activity must provide the Secretary of Commerce with a written description of the activity and its effects "at the earliest possible time," 16 U.S.C. § 1434(d)(1)(B), and the Secretary must recommend alternatives to protect sanctuary resources if he believes those resources will be adversely affected. 16 U.S.C. § 1434(d)(2). If the alternatives are not adopted, the permitting agency must explain why not. 16 U.S.C. § 1434(d)(3). Although the ATOC project will likely cause injury to living sanctuary resources such as the various species of whales that will be taken, it does not appear that this requirement to consider alternatives has been met.

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In light of these statutory requirements, the Secretary of Commerce should, at a minimum, have been notified of the ATOC permit applications, and should prepare comments and recommend alternatives to protect the Hawaiian Islands and Monterey Bay Sanctuaries' resources. Consistent with the intent and spirit of the Marine Sanctuary Act and its implementing regulations, we do not believe that the Secretary may, within his reasonable discretion, sanction the ATOC proposal.

Respectfully submitted,

HELLER, EHRMAN, WHITE & McAULIFFE

Joshua R. Floum
Sylvia Quast
Attorneys for NRDC

cc: Joél R. Reynolds, Esq.
NRDC
Mr. Terry Jackson
Monterey Bay National Marine Sanctuary
Denise Antolini
Sierra Club Legal Defense Fund

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"We, as marine mammal scientists, understand the difficulties and limitations of studying marine mammals, especially whales and dolphins, in the wild. We recognize that our information on the hearing sensitivities and on the diving abilities of most marine mammals is limited, and that we do not yet know what the subtle, long-term effects of noise on marine mammals might be. Given these uncertainties, we do not feel that it is prudent to proceed at this time with the "ATOC" (Acoustic Thermometry of Ocean Climate) experiment, which will broadcast extremely loud (195 dB), low frequency (ca. 70 Hz) sounds at a depth of around 850 m, off Pt. Sur, California and Kauai, Hawaii, every 4 hrs. for a duration of 20 min., around the clock, for about 2 years, more probably decades. We are also uncertain of the effects these loud sounds might have on the whole deep ocean ecosystem, which may be vital to the well-being of marine mammals."

Sylvia A. Earle, Ph.D.	Founder Deep Ocean Engineering
Katharine B. Payne	Visiting Fellow Cornell University
Linda S. Weilgart, Ph.D.	Post Doctoral Fellow Cornell University
Louis M. Herman, Ph.D.	Professor and Director Kewalo Basin Marine Mammal Laboratory University of Hawaii
David Wiley, Ph.D.	Senior Scientist International Wildlife Coalition
Paul K. Anderson, Ph.D.	Emeritus Professor of Zoology University of Calgary
Jim Darling, Ph.D.	Tofino, British Columbia
Hal Whitehead, Ph. D.	Associate Professor of Biology Dalhousie University
Stephen M. Dawson, Ph.D.	Lecturer, Marine Science University of Otago
Bill Amos, Ph.D.	Molecular Ecology Group, Cambridge Univ.

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Michael J. Moore, Vet. M.B. Ph.D.	Visiting Investigator Woods Hole Oceanographic Institute
Elisabeth Slooten, Ph.D.	Lecturer, Marine Science Otago University
W. Nigel Bonner, Ph.D.	Project Director South Georgia Whaling Museum
Jonathan Gordon, Ph.D.	Scientific Director "Song of the Whale Project" International Fund for Animal Welfare Visitor Wildlife Conservation Research Unit University of Oxford
Carole Carlson, Ph.D.	

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Natural Resources Defense Council

6310 San Vicente Blvd., Suite 250
Los Angeles, CA 90048
213 934-6900
Fax 213 934-1210

BY FAX

March 21, 1994

Rolland A. Schmitten
Assistant Administrator for Fisheries
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Re: Supplemental Comments on Application for Scientific Research Permits (P557) to Take Marine Mammals and Other Species -- Acoustic Thermometry of Ocean Climate Program ("ATOC")/Pt. Sur, California and Kauai, Hawaii

Dear Mr. Schmitten:

These comments supplement those previously submitted by the Natural Resources Defense Council ("NRDC") regarding the permit applications cited above.

(1) The validity of the take estimates in both of the pending applications is uncertain given the fact that, according to the application (at 2-3), "animals could be considered to be 'exposed' during each source 'on' duty cycle (for 1994, approximately 1530 times; for 1995, approximately 2040 times); in some cases, such 'exposures' could be considered multiple takes of the same animal." Thus, even though the "maximum potential take would include the entire population" (id. at 4), actual take may far exceed that amount. The Marine Mammal Protection Act requires that, as an essential precondition to issuance of a permit, the estimate of take must be accurate and reliable.

(2) The pending applications are, and must be analyzed as, initial steps in the overall ATOC planning process. In that regard, it should be noted that a descriptive brochure apparently issued by the Advanced Research Projects Agency states that "[l]ong lead planning is underway to expand the acoustic network to the Indian and southern Atlantic Oceans ...." (See Exhibit A hereto.)

(3) We understand that the Conservation Advisory Committee for the Monterey Bay National Marine Sanctuary was not informed of the ATOC project until very recently and, even then, only through informal,

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outside channels. Given the potential significance of the project and the location of the sound source within the boundaries of the Sanctuary, we believe that input from the committee should have been solicited at the outset, in order to allow a meaningful opportunity for local comment.

Very truly yours,

Joel R. Reynolds
Senior Attorney

Ann Notthoff
Senior Planner

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NRDC

Natural Resources
Defense Council

6310 San Vicente Blvd., Suite 250
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BY FAX

March 17, 1994

Rolland A. Schmitten
Assistant Administrator for Fisheries
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Re: Supplemental Comments on Application for Scientific Research Permits (P557) to Take Marine Mammals and Other Species -- Acoustic Thermometry of Ocean Climate Program ("ATOC")/Pt. Sur, California and Kauai, Hawaii

Dear Mr. Schmitten:

These comments supplement those previously submitted by the Natural Rersources Defense Council ("NRDC") regarding the permit applications cited above.[1] This letter outlines the legal obligations imposed by the National Environmental Policy Act ("NEPA") on all federal agencies, including the National Marine Fisheries Service ("NMFS"), the National Oceanic and Atmospheric Administration ("NOAA"), and the Department of Commerce (collectively "NMFS"). We believe that NEPA requires a full and searching environmental review of the subject applications before a decision is rendered.

Enacted by Congress in 1969, NEPA establishes a national environmental policy to "encourage productive and enjoyable harmony between man and his environment" and "promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man." 42 U.S.C. § 4321. In order to achieve its broad goals, NEPA mandates that "to the fullest extent possible" the "policies, regulations, and public laws of the United States shall be

---

1 On March 3, 1994, we submitted comments and a request for hearing limited to the Pt. Sur application. Because the Kauai application and modification raise many of the same legal and factual concerns, we request that those comments and request for hearing be considered with regard to the Kauai project as well. Among additional concerns regarding the Kauai project, we note that the Hawaiian monk seal, which is listed as one of the species to be taken, has been designated as depleted under the provisions of the Marine Mammal Protection Act. 50 C.F.R. § 216.15.

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interpreted and administered in accordance with [NEPA]." 42 U.S.C. § 4332.

The heart of NEPA is its requirement that "all agencies of the Federal Government" (id. (emphasis added)) prepare an environmental impact statement for any project that "may significantly degrade some human environmental factor." Steamboaters v. F.E.R.C., 759 F.2d 1382, 1392 (9th Cir. 1985) (emphasis in original).[2] As the Supreme Court explained:

> NEPA's instruction that all federal agencies comply with the impact statement requirement - and with all the other requirements of § 102 - "to the fullest extent possible," 42 U.S.C. § 4332, is neither accidental nor hyperbolic. Rather the phrase is a deliberate command that the duty NEPA imposes upon the agencies to consider environmental factors not be shunted aside in the bureaucratic shuffle.

Flint Ridge Development Co. v. Scenic Rivers Ass'n, 426 U.S. 776, 787 (1976).[3]

---

[2] The purpose of an EIS is to ensure that federal agencies and the public are informed about the broad range of environmental impacts that may be associated with a project, consider alternatives, and carefully weigh the merits of the project against those alternatives:

> By "gather[ing] in one place a discussion of the relative environmental impact of alternatives," NRDC v. Morton, 458 F.2d 827, 834 (D.C.Cir. 1972), the EIS makes it possible for the public and reviewing courts to consider conveniently how and why the agency made its final choices.

Friends of the River v. F.E.R.C., 720 F.2d 93, 106 (D.C. Cir. 1983). See also LaFlamme v. F.E.R.C., 852 F.2d 389, 398 (9th Cir. 1988) (NEPA's goal is to facilitate "widespread discussion and consideration of the environmental risks and remedies associated with the pending project.").

[3] Specifically, NEPA provides that:

> The Congress authorizes and directs that, to the fullest extent possible . . . (2) all agencies of the Federal Government shall --
>
> * * *

(continued...)

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The Ninth Circuit has recognized that the congressional mandate to apply NEPA "to the fullest extent possible" is "a direction 'to make as liberal an interpretation as we can to accommodate the application of NEPA.'" LaFlamme v. F.E.R.C., 852 F.2d 389, 398 (9th Cir. 1988)(quoting Jones v. Gordon, 792 F.2d 821, 826 (9th Cir. 1981).[4] As a result, the courts have consistently required that an EIS be prepared unless the agency has made a "fully informed and well-considered" decision that a project will have no significant impact on the environment. Jones, 792 F.2d at 826. See also Save the Yaak Committee v. Block, 840 F.2d 714, 717 (9th Cir. 1988); Foundation for North American Wild Sheep v. U.S. Dep't of Agriculture, 681 F.2d 1172, 1178 (9th Cir. 1982); Steamboaters, 759 F.2d at 1393-94.

In addition to and independent of its requirement of an environmental impact statement, NEPA also directs all federal

---

[3](...continued)

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on --

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

42 U.S.C. § 4332 (emphasis added).

[4] See also Foundation for North American Wild Sheep v. U.S. Dept. of Agriculture, 681 F.2d 1172 (9th Cir. 1982) ("we note the exceptionally broad scope of NEPA").

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agencies to "study, develop, and describe appropriate alternatives" to any project involving unresolved conflicts in "alternative uses of available resources." 42 U.S.C. § 4332(2)(E). Section 102(2)(E) provides that

> all agencies of the Federal Government shall
>
> * * *
>
> (E) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources ....

This alternatives requirement has been repeatedly applied by the courts, and each has concluded that it is "both independent of, and broader than, the EIS requirement." Bob Marshall Alliance v. Hodel, 852 F.2d 1223, 1229 (9th Cir. 1988), cert. denied, 109 S.Ct. 1340 (1989). The provision, moreover, is mandatory "even where a proposed action does not trigger the EIS process." Id.[5]

As early as 1974, in Environmental Defense Fund v. Corps of Engineers of the U.S. Army, 492 F.2d 1123, 1135 (5th Cir. 1974), the Fifth Circuit Court of Appeals applied § 102(2)(E)[6] and explained as follows its purpose and relationship to the alternatives requirement of an EIS:

> Clearly, Section 102(2)([E]) is supplemental to and more extensive in its commands than the requirement of 102(2)(C)(iii). It was intended to emphasize an important part of NEPA's theme that all change was not progress and to insist that no major federal project

---

[5] Accord City of Aurora v. Hunt, 749 F.2d 1457, 1466 (10th Cir. 1984); City of New York v. The United States Department of Transportation, 715 F.2d 732, 742-43 (2d Cir. 1983), cert denied, 465 U.S. 1055 (1984); Aertsen v. Landrieu, 637 F.2d 12,20 (1st Cir. 1980); Nucleus of Chicago Homeowners Association v. Lynn, 524 F.2d 225, 232 (7th Cir. 1975), cert. denied, 424 U.S. 967, 96 S.Ct. 1462 (1976); Trinity Episcopal School Corp. v. Romney, 523 F.2d 88, 93 (2d Cir. 1975); Hanly v. Kleindienst, 471 F.2d 823, 834-36 (2d Cir. 1972), cert. denied, 412 U.S. 908, 93 S.Ct. 2290 (1973); California v. Bergland, 483 F.Supp. 465, 488 (E.D.Cal. 1980), aff'd sub nom. California v. Block, 690 F.2d 753 (9th Cir. 1982).

[6] Section 102(2)(E) of NEPA was originally numbered § 102(2)(D) and was subsequently renumbered by amendment. See Pub. L. 94-83, 89 Stat. 424 (1975).

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> should be undertaken without intense consideration of other more ecologically sound courses of action, including shelving the entire project, or of accomplishing the same result by entirely different means. [Emphasis added.]

The court further emphasized the breadth of alternatives contemplated by § 102(2)(E):

> The imperative directive is a thorough consideration of all appropriate methods of accomplishing the aim of the action, including those without the area of the agency's expertise and regulatory control as well as those within it.

Id. (citing Natural Resources Defense Council v. Morton, 458 F.2d 827, 834 (D.C. Cir. 1972) (emphasis added).

More recently, the Court of Appeals for the Eighth Circuit addressed the scope of § 102(2)(E) in Olmstead Citizens For A Better Community v. United States, 793 F.2d 201, 208 (8th Cir. 1986). Noting the "'supplemental' and 'more extensive' command" of the requirement relative to an EIS, the court observed that 102(2)(E)

> imposes not a duty to publish an even more thorough explanation than in an impact statement but instead a duty to actively seek out and develop alternatives as opposed to merely writing out options that reasonable speculation suggest might exist.... The case proposes, for example, that an agency should consider "shelving the entire project" or "accomplishing the same result by entirely different means" ....

Id. at 208 (emphasis added) (citations omitted).

Perhaps the most extensive discussion of § 102(2)(E) appears in the Ninth Circuit's decision in Bob Marshall Alliance, 852 F.2d 1223. In Marshall, wilderness preservation groups challenged the issuance by the Department of the Interior of oil and gas leases in designated wilderness areas of national forest land. In concluding that the leases violated the agency's obligations under NEPA to consider alternatives, the court of appeals addressed the specific differences between § 102(2)(E) and the independent alternatives section of an EIS, concluding that the former is broader and is required even where an EIS is not:

> Moreover, consideration of alternatives is critical to the goals of NEPA even where a proposed

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> action does not trigger the EIS process. This is reflected in the structure of the statute: while an EIS must also include alternatives to the proposed action, 42 U.S.C. § 4332(2)(C)(iii) (1982), the consideration of alternatives requirement is contained in a separate subsection of the statute and therefore constitutes an independent requirement. See id. § 4332(2)(E). *The language and effect of the two subsections also indicate that the consideration of alternatives requirement is of wider scope than the EIS requirement. The former applies whenever an action involves conflicts, while the latter does not come into play unless the action will have significant environmental effects. An EIS is required where there has been an irretrievable commitment of resources; but unresolved conflicts as to the proper use of available resources may exist well before that point. Thus the consideration of alternatives requirement is both independent of, and broader than, the EIS requirement.* In short, any proposed federal action involving unresolved conflicts as to the proper use of resources triggers NEPA's consideration of alternatives requirement, whether or not an EIS is also required.

Id. at 1228-29 (emphasis added) (citations omitted).

These decisions reflect the clear legislative intention to mandate comprehensive and systematic consideration of alternatives, through both the EIS process and the independent alternatives study requirement, as part of the decisionmaking processes of "all agencies of the Federal Government." 42 U.S.C. § 4332(2). They further establish that § 102(2)(E) applies regardless of whether a full EIS is required.[7] Congress intended -- and the courts have enforced -- an independent obligation of all federal agencies to "study, develop, and describe" appropriate alternatives, even where an EIS, for whatever reason, is not required.

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7 In addition, the Council on Environmental Quality, the agency charged with administering NEPA, reached the same conclusion.

> Th[e] requirement of § 102(2)(E) extends to all such proposals, not just the more limited scope of (2)(C)(iii) where the discussion of alternatives is confined to Impact Statements.

40 C.F.R. § 1507.2(d).

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This legal analysis is directly relevant to the subject applications for permits pending before NMFS. First, the permits will authorize actions that would significantly affect the environment in a broad range of ways,[8] with potentially devastating consequnces to irreplaceable resources. In addition, the permits clearly concern issues of substantial scientific controversy -- a fact that supports the need for full NEPA analysis. An EIS is thus required. Second, the requested authority clearly implicates an unresolved conflict between alternative uses of available resources -- our oceans and associated marine environment (including a broad range of species) -- requiring the development and study of alternatives independent of the EIS requirement. Absent such analyses, the requested permits cannot legally be issued.

Very truly yours,

Joel R. Reynolds
Senior Attorney

Ann Notthoff
Senior Planner

cc: Terry Jackson, Manager
Monterey Bay National Marine Sanctuary

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[8] Among the obvious impacts to be considered are the cumulative effects of the Pt. Sur, Kauai, and planned Indian Ocean and south Atlantic Ocean projects. To our knowledge, no consideration has been given to what the effects of these projects, taken together, might be. NEPA requires that such analysis be done and publicly disclosed before decisions on the pending applications are rendered.

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Natural Resources Defense Council

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BY FAX

March 3, 1994

Rolland A. Schmitten
Assistant Administrator for Fisheries
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Re: Comments and Request for Hearing on Application for Scientific Research Permit (P557A) to Take Marine Mammals and Other Species -- Acoustic Thermometry of Ocean Climate Program ("ATOC")/Pt. Sur, California

Dear Mr. Schmitten:

On behalf of the Natural Resources Defense Council ("NRDC") and its members, we write briefly to raise concerns regarding the pending application for a scientific research permit (P557A) to take a range of species of marine mammals and sea turtles in the vicinity of Pt. Sur, California in connection with the Acoustic Thermometry of Ocean Climate ("ATOC") Program. NRDC is a national non-profit organization with approximately 170,000 members nationwide, active in issues of water quality, species protection, and habitat preservation.

The subject application seeks permission to install and operate in the heart of the Monterey Bay National Marine Sanctuary a sound source that will generate a noise level of approximately 195 dB, an estimated 10,000,000 times the level at which gray whales reportedly show avoidance of noise. The speakers would operate on a duty cycle of 20 minutes on, four hours off, 20 minutes on, four hours off, 24 hours per day for the next two years at least. Similar experiments are planned for this Spring in Hawaii, off the coast of Kauai, and plans have already begun to extend the project to the Indian and southern Atlantic Oceans.

The Pt. Sur application requests a permit to "take" a staggering number of some 22 species of marine mammals (many of them endangered or threatened), including 474,220 common dolphins, 193,197 Pacific white-sided dolphins, 50,416 Risso's dolphins, 145,033 Dall's porpoises, 174,000 northern elephant seals, 244,000 California sea lions, 41,738 gray whales, 3,847 blue whales, 1,598 fin whales, 996 Minke whales, 1,066 humpback whales, 2,503 beaked whales, 1,500 sperm whales, and many, many more. Four species of sea turtles, as well as numerous varieties of fish, may also be taken by the project.

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Totally apart from the scientific interest of the planned experiments -- which we do not question here -- we believe the application raises serious and fundamental issues about use and protection of our marine environment. Without question, the application would cause significant noise pollution throughout the Pacific Ocean, a significant adverse impact for which, apparently, little attempt to mitigate has been made. Also undeniable is the serious intrusion upon marine species and one of the most environmentally rich and sensitive marine environments on the west coast, an intrusion that may have significant and unknown adverse impacts on numerous species whose survival depends on their ability to hear or be heard. Finally, we are surprised by the fact that the research will apparently not be conducted in an experimental fashion -- that is, by using a graduated duty cycle that would allow marine scientists to monitor over an adequate period of time what impacts there may be from a slowly increasing level of noise.

We believe that these issues and others -- including those raised in the attached documents and incorporated herein by reference -- warrant further study and attention. In addition, a number of federal statutes require objective disclosure and analysis of potential impacts (individually and cumulatively), consideration of alternatives, and maximum practicable mitigation of impacts to ensure that the proposed permit will not needlessly or carelessly destroy or harm the affected environment or species.[1] These statutes mandate such consideration before any final action by NMFS on the pending application.

For the foregoing reasons, we are concerned that no environmental impact statement ("EIS") has been prepared or required by NMFS under the National Environmental Policy Act nor, we are told, is one planned. No Biological Opinion has yet been prepared by NMFS under the Endangered Species Act, although one is expected. No decision has apparently been made on whether to require a hearing, although, according to NMFS staff, at least two requests for hearing have been filed. Under the circumstances, and regardless of what decision may ultimately be made by NMFS on the application, we believe that an EIS

---

[1] See, e.g., the National Environmental Policy Act, 42 U.S.C. § 102(2)(C) and (E); the Marine Mammal Protection Act, 16 U.S.C. §§ 1361 et seq.; the Endangered Species Act, 16 U.S.C. §§ 1531 et seq.; the Coastal Zone Management Act, 16 U.S.C. § 1456(c)(1)(A); and any federal or state laws enacted to protect marine resources or marine sanctuaries, including the Marine, Research and Sanctuaries Act, 16 U.S.C. § 1431 et seq.

Scoping Comments
(Responses)

Preparer's Note

A letter originated by Dr. C. Clark to Ms. K. Svitil, dated 16 December 1994, was inadvertently included in this section of the DEIS. Its inclusion was indeliberate, as it was not a scoping comment and, as such, it is not included in this FEIS. We regret any inconvenience or misunderstanding that this may have caused.

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA 92093

January 25, 1995

Gregory G. Y. Pai, PhD
Director
Office of State Planning
PO Box 3540
Honolulu, HI 96811-3540

Re: Federal Consistency Review for the Acoustic Thermometry of Ocean Climate (ATOC) Program

Dear Dr. Pai:

University of California, San Diego, Scripps Institution of Oceanography (Scripps) hereby submits to the Office of Coastal Zone Management, Office of State Planning, a copy of Scripps' certification of consistency with the Hawaii Coastal Zone Management Program prepared in connection with the Acoustic Thermometry of Ocean Climate (ATOC) Program, which is proposed to be carried out near Kauai, Hawaii. We ask that the state review Scripps' submittal and concur in the conclusion that the ATOC Program is consistent with the HCZMP.

Concurrently, Scripps is submitting the certification of consistency to the National Marine Fisheries Service (NMFS) and the U. S. Army Corps of Engineers. Scripps has applied to NMFS for a scientific research permit under the Marine Mammal Protection Act, and has requested authorization from the Corps to utilize one or more nationwide permits issued under Section 10 of the Rivers and Harbors Act. Both types of permits are listed in the Hawaii Coastal Zone Management Program (HCZMP).

Along with the certification of consistency, we enclose several items which provide supporting data and information for your use in reviewing the project. The enclosures are: the state-federal Draft Environmental Impact Statement (two volumes); the completed HCZMP Assessment Form; a copy of Scripps' letter of August 29, 1994, to Lt. Colonel Bruce Elliot of the Honolulu District Corps of

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Engineers concerning the nationwide Section 10 permits; a copy of the MMPA scientific research permit application to NMFS; and a copy of the conservation District use permit application to the Hawaii Department of Land and Natural Resources.

These materials are all part of Scripps' consistency statement and are intended to satisfy the requirements of 15 C.F.R. Section 930.58 for supporting information and data. We ask that you provide confirmation of a determination regarding the completeness of this submittal at the earliest possible time. If you determine that additional materials are needed or if, in the course of your staff's review of this project, any questions arise, please feel free to call Russ Albertson at the ATOC Project Office (619-534-7529), our attorney Mary Hudson (510-465-4494), or myself.

Sincerely,

Andrew Forbes
Program Manager

cc: (without enclosures)

Ann Terbush, NMFS
Lt. Colonel Bruce Elliot, U.S.A.C.O.E.

Enclosures: Consistency Certification
HCZMP Assessment Form
Draft Environmental Impact Statement
MMPA Permit Application
Letter from Scripps to COE, 8.29.94
Conservation District Use Permit Application

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Mary L. Hudson
ATTORNEY AT LAW

January 19, 1995

Michael T. Lee, Chief
Operations Division
U. S. Army Corps of Engineers, Honolulu District
Fort Shafter Bldg. 230
Honolulu, HI 96858-5440

Re: Acoustic Thermometry of Ocean Climate Project

Dear Mr. Lee,

This will follow up on our last telephone conversation, on December 13, 1994, concerning the Acoustic Thermometry of Ocean Climate (ATOC) research project which the University of California, Scripps Institution of Oceanography, proposes to implement in waters adjacent to the island of Kauai. After Scripps' August 29 letter to the Corps concerning authorization to use certain nationwide permits, some uncertainty had arisen whether the only permits involved would be one or more permits under § 10 of the Rivers and Harbors Act, or whether a Clean Water Act § 404 permit would also be required.

Following our conversation on December 13, I informed the Hawaii Department of Health of your decision that no §404 permit would be required for the ATOC-related work described in Scripps' August 29 letter. DOH was considering the question of whether water quality certification would be needed under § 401. Ultimately, the Department concluded that no such certification would be needed at this time. A copy of an explanatory letter from Deputy Attorney General Lawrence Lau is enclosed.

As indicated by Mr. Lau's letter, DOH would like to see written confirmation of the Corps' decision concerning the appropriate permit. I am writing to request confirmation of such a letter, if it has not already been provided to the Department.

Within the next few days, Scripps will be submitting its federal consistency certification to the Corps and providing a copy and supporting data and information to

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the State Coastal Zone Management Office for federal consistency review. Please feel free to call me if you have any questions relating to these matters.

Sincere

Mary L. Hudson

Terrell Kelly, COE
Lawrence K. Lau, DAG

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

LA JOLLA, CALIFORNIA 92093

December 21, 1994

Mr. Don Hibbard, Administrator
State Historic Preservation Division
Department of Land and Natural Resources
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

Re: Acoustic Thermometry of Ocean Climate Project

Dear Mr. Hibbard:

Thank you for your response to the DLNR consultation notice on the above project. We will keep your division advised of any changes in the project which could affect division responsibilities.

Sincerely,

Andrew Forbes
ATOC Project Manager

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

LA JOLLA, CALIFORNIA 92093

December 21, 1994

Paul Kawamoto
Aquatic Biology Program Manager
Division of Aquatic Resources
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Re: Acoustic Thermometry of Ocean Climate Project

Dear Mr. Kawamoto:

Thank you for your September 6 letter of comment concerning the proposed Acoustic Thermometry of Ocean Climate project and the related Marine Mammal Research Program. The following information responds to points raised in your letter.

You raise questions regarding possible effects of project activities on fish around the fish aggregating device (FAD) which is 8 miles ESE of the source site. Because of the distance separating these facilities and the fact that the cable's approach is from the south west, there should be no physical conflicts between the facilities. See DEIS Section 5.

You note that there is commercial fishing activity in the area of the sound source and that little is known about the effect of low-frequency sounds upon fish. You suggest monitoring and investigating such effects as part of the project research on effects upon marine animals. Description of demersal and pelagic fish species with the project area is included in Section 3.3.3 of the DEIS. Commercial fishing activities are discussed in Section 5. Possible effects of the source sound emissions upon fish is discussed in Section 4.3.2.2 of the DEIS. The Marine Mammal Research Program will include monitoring to fish stock assessments to attempt evaluation of the potential for increased predation on fish and for impacts to the behavior of fish, particularly sharks. See Section 4.3.2.2.1.

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P. Kawamoto
December 21, 1994
Page 2

The DEIS responds, in Section 1, to your request that the need for using acoustic thermometry for measuring ocean climate. Other methods of collecting ocean thermal data are also discussed and compared in Section 2.

Finally, you register your objection to after-the-fact approval of the cable installation. This issue is addressed in DEIS Section 1, regarding the ATOC physical facilities, and in Section 5, regarding regulatory requirements. The subsea cable, which connects to a pre-existing Navy cable offshore from Barking Sands, was laid by the Navy at a time (October 1983) when a Navy vessel was available for that purpose. Generally speaking, federal activities are exempt from many state requirements. However, in order to ensure complete regulatory compliance, the Scripps Institution of Oceanography has requested that the Department of Land and Natural Resources ("DLNR") issue it a permit for the installation of the cable on state lands that was made by the Navy. The cable has simply been placed on the surface of the seabed and will not be connected or used until completion of the permit process.

We appreciate your stated interest in research leading to greater knowledge of the ocean and its marine life. We anticipate being able to share our research results with interested agencies such as the Division of Aquatic Resources.

Sincerely,

Andrew Forbes
ATOC Program Manager

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA 92093

December 19, 1994

Center for World Peace
Box 830
Waialua, Molokai
Hawaii 96748

Dear Mr. Sutcliffe:

This letter responds to the November 7, 1994, scoping comments submitted by you on behalf of the Center for World Peace ("CWP"). Your letter attaches an April 14, 1994, letter to Ann Terbush at the National Marine Fisheries Service ("NMFS") that you requested be put on record.

Several of your comments are within the scope of more extensive comment letters submitted by the Sierra Club Legal Defense Fund ("SCLDF") on behalf of a number of Hawaii organizations; a copy of our response to SCLDF's comments is attached for your information.

This letter restates the principal comments made, and includes a summary response to each. The draft environmental impact statement addresses most of these issues in considerably greater detail, and should be referred to for a more extensive discussion.

Your letter also combines comments on the scope and substance of the EIS, the merits of the pending scientific research permit application to NMFS, and specific information regarding many of the questions addressed in the DEIS. This letter focuses on the treatment of the substantive and scoping issues that you have raised; the DEIS itself integrates much of the information that you have provided.

CWP Scoping Comment (1): A programmatic EIS should be prepared, considering the impacts of a "long-term global network."

Generally speaking, the National Environmental Policy Act ("NEPA") takes a flexible and practical approach to the required scope of an EIS. Here, the structure selected consists of individual environmental impact statements for the Kauai and California cabled source installations and associated Marine Mammal Research Programs ("MMRPs"), an environmental assessment for the acoustic engineering test ("AET"), and anticipated future environmental

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review of any additional ATOC activities beyond the initial two year feasibility study described in the Kauai and California EISs.

Separate EISs for Kauai and California were preferred because of the differing (1) environmental settings, (2) state "lead" or "approving" agencies and state law requirements, (3) interested communities, and (4) resulting impacts, among other factors. A combined EIS would have been cumbersome and awkward, mixing differing state requirements in Kauai and California and presenting most readers with information about a proposed installation some distance away from the area of their principal concern. However, logistics permitting, the Kauai and California EISs are being processed on timetables which allow for a coordinated and near-contemporaneous analysis.

As described in greater detail in Section 1 of the DEIS, future ATOC project activities are too speculative to permit environmental analysis at this time. While the ATOC project office has sought funds for the initial feasibility demonstration work in part based upon the potential for a future global network, the details of future proposals currently remain open and are not sufficiently defined to be analyzed. Obviously, if one were to assume that any long-term transmissions would be at similar frequencies, intensities and locations as analyzed in the DEIS, the impacts would likely be similar; the validity of this assumption, however, will not be known until the initial feasibility work has been completed.

See our response to SCLDF Comment 2 for additional discussion of this issue.

CWP Scoping Comment (2): The EIS must comprehensively analyze the potential effects of the ATOC project on Hawaii's humpback whales and other marine animals.

This is the principal subject area of the DEIS, addressed primarily in Section 4.

CWP Scoping Comment (3): Discuss the consistency of the ATOC project in Hawaii with applicable plans, policies, and controls, including the Humpback Whale Recovery Plan, as well as the Humpback Hawaiian Islands Humpback Whale National Marine Sanctuary.

This is the subject of Section 5 of the DEIS.

CWP Scoping Comment (4): Discuss the "premature" laying of the subsea cable in October, 1993.

This issue is addressed in DEIS Section 1, regarding the ATOC physical facilities, and in Section 5, regarding regulatory requirements. The subsea cable,

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which connects to a pre-existing Navy cable offshore from Barking Sands, was laid by the Navy at a time (October 1983) when a Navy vessel was available for that purpose. Generally speaking, federal activities are exempt from many state requirements. However, in order to ensure complete regulatory compliance, the Scripps Institution of Oceanography ("Scripps") has requested that the Department of Land and Natural Resources ("DLNR") issue it a permit for the installation of the cable on state lands that was made by the Navy. The cable has simply been placed on the surface of the seabed and will not be connected or used until completion of the permit process.

CWP Scoping Comment (5): Include possible effects of ATOC on humans.

This discussion is presented in Section 4 of the EIS.

CWP Scoping Comment (6): Articulate a standard of significance, i.e. a standard of harm that will guide whether the transmissions continue. Identify who will implement the standard and make the decision whether to proceed with the project.

This presentation is included in Appendix C. The ATOC project is also suggesting the formation of a Community Advisory Group ("CAG") to interact with the program and advise on important decisions, including source termination decisions. The composition and structure of the CAG has not yet been developed, since it is anticipated that interested parties may wish to make proposals and suggestions regarding the CAG in their comments on the DEIS.

In sum, the authors of the DEIS have carefully reviewed your scoping comments and have made every effort to integrate and address them in the document. We trust that you will participate in the public review of the document and provide us with the benefit of your comments.

Sincerely,

Andrew Forbes
ATOC Program Manager

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LA JOLLA, CALIFORNIA 92093

December 19, 1994

Mark Smaalders
Sierra Club Legal Defense Fund
223 S. King Street, 4th Floor
Honolulu, HI 96813

Re: Acoustic Thermometry of Ocean Climate & Marine Mammal Research Programs

Dear Mr. Smaalders:

This letter responds to the November 7, 1994, scoping comments submitted by the Sierra Club Legal Defense Fund ("SCLDF"), on behalf of a number of Hawaii organizations regarding the Draft Environmental Impact Statement ("DEIS") for the Acoustic Thermometry of Ocean Climate ("ATOC") project offshore from Kauai. Your letter directly raises several issues, and also incorporates five previous comment letters that have been submitted by SCLDF to the National Marine Fisheries Service ("NMFS") and Advanced Research Projects Agency ("ARPA").

Since many of the comments in these six letters overlap, and to provide a more ordered response, this letter restates the principal comments made, and includes a summary response to each. The draft environmental impact statement addresses most of these issues in considerably greater detail, and should be referred to for a more extensive discussion.

Your six letters also combine comments on the scope and substance of the EIS, the merits of the pending scientific research permit application to NMFS, and specific information regarding many of the questions addressed in the DEIS. This letter focuses on the treatment of the substantive and scoping issues that you have raised; the DEIS itself integrates much of the information that you have provided.

SCLDF Scoping Comment (1): The EIS must comprehensively analyze the potential effects of the ATOC project on Hawaii's humpback whales and other marine animals, including threatened and endangered species, sea turtles and prey species.

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This is the principal subject area of the DEIS, addressed primarily in Section 4.

SCLDF Scoping Comment (2): A programmatic EIS should be prepared, considering the impacts of a "long-term global network."

Generally speaking, the National Environmental Policy Act ("NEPA") takes a flexible and practical approach to the required scope of an EIS. Here, the structure selected consists of individual environmental impact statements for the Kauai and California cabled source installations and associated Marine Mammal Research Programs ("MMRPs"), an environmental assessment for the acoustic engineering test ("AET"), and anticipated future environmental review of any additional ATOC activities beyond the initial two year feasibility study described in the Kauai and California EISs. The playback experiment was originally authorized by NMFS in February 1993 under a NEPA categorical exclusion for such research permits, and the modification request involves no significant changes. (See response to Comment 27, below.)

Separate EISs for Kauai and California were preferred because of the differing (1) environmental settings, (2) state "lead" or "approving" agencies and state law requirements, (3) interested communities, and (4) resulting impacts, among other factors. A combined EIS would have been cumbersome and awkward, mixing differing state requirements in Kauai and California and presenting most readers with information about a proposed installation some distance away from the area of their principal concern. However, logistics permitting, the Kauai and California EISs are being processed on timetables which provide a basis for coordination and near-contemporaneous analysis.

As described in greater detail in Section 1 of the DEIS, future ATOC project activities are too speculative to permit environmental analysis at this time. While the ATOC project office has sought funds for the initial feasibility demonstration work in part based upon the potential for a future global network, the details of future proposals currently remain open and are not sufficiently defined to be analyzed. Obviously, if one were to assume that any long-term transmissions would be at similar frequencies, intensities and locations as analyzed in the DEIS, the impacts would likely be similar; the validity of this assumption, however, will not be known until the initial feasibility work has been completed.

Your comments also state that a programmatic EIS including future activities and the AET is required at this time. We disagree. The question is addressed under Section 1508.25 of the NEPA guidelines, which provide that "connected actions," as defined, "should" be discussed in the same impact statement. Actions are connected if they:

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(i) Automatically trigger other actions which may require environmental impact statements.

(ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.

(iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

40 C.F.R. 1508.25. In previous letters SCLDF has focused on subsection (iii), implying correctly that subsections (i) and (ii) do not apply. Specifically, none of the ATOC project components "automatically" trigger other actions and in fact they are all quite separable. For example, it would be possible to install and operate only one of the cabled sources in California or Kauai, to carry out playback experiments totally outside the context of these studies, or to further evaluate the engineering considerations presented by the ATOC proposal through additional engineering tests. None of these activities are preconditions or prerequisites for the others.

In interpreting subsection (iii), the courts have applied an "independent utility" standard, requiring that: "The dependency is such that it would be irrational, or at least unwise, to undertake the first phase if subsequent phases were not also undertaken." Blue Ocean Preservation Society v. Watkins, 754 F.Supp. 1450, 1458 (D.HW. 1991). Under this decision, independent utility means utility "such that the agency might reasonably consider constructing only the [facility] in question." Id. at 1459.

The Kauai and California cabled source proposals, as well as the AET and playback experiments, all have independent utility under this standard, since they all could rationally be undertaken independently of the other activities. In fact, since permits have not yet been issued for the cabled sources, there is no assurance that all components of the ATOC project will proceed; it nonetheless remains the intention of the project to proceed with those activities that do receive all required approvals.

These various activities are not "related to each other closely enough to be, in effect, a single course of action" and therefore do not need to be the subject of a single EIS.

In addition, no harm to the environmental review process will result from this organization of the documents and, in our view, public review and comment will be enhanced by the ability to focus on the geographically distinct activities. Moreover, no impacts will be ignored or minimized by this approach, since each document fully addresses the impacts of the activity being covered, and the two EIS documents dovetail and incorporate one another.

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While it would have been acceptable for the Kauai and California source proposals to have been analyzed in a single document, given the flexibility provided by NEPA, a combined analysis is not required and, in fact, would have been less useful for the public and decision makers given the factors discussed above.

SCLDF Scoping Comment (3): The proposed acoustic engineering test (already completed) and playback studies should not proceed until a programmatic EIS has been prepared.

See response to comment 2. The playback experiments originally were suggested by the ATOC Marine Mammal Research Program Advisory Board, an independent group of scientists and other interested individuals. Drs. Tyack and Whitehead were among the concerned scientists that pressed for playback experiments; the playback experiments were essentially an environmentalist proposal. The playback experiments are the initiative of the Advisory Board, and Scripps would be very reluctant to make any changes to those experiments that are not agreed to by the Advisory Board. Potential cumulative impacts of these related projects and MMRP and ATOC activities are discussed in the EIS.

SCLDF Scoping Comment (4): Both the Kauai and Point Sur locations should be evaluated in a single EIS.

See response to comment 2, above.

SCLDF Scoping Comment (5): Evaluate alternative source sites.

Section 2, regarding alternatives, contains a comprehensive discussion of the global, sub-basin and local screening of potential source sites, carrying forward alternative sites for detailed analysis.

SCLDF Scoping Comment (6): Consider alternative methods of measuring ocean temperatures, including direct measurements and satellite measurements.

Section 2, regarding alternatives, contains a comprehensive discussion of the alternative methods for measuring ocean temperatures, carrying forward alternative technologies for a detailed analysis.

SCLDF Scoping Comment (7): Describe the ATOC physical installation, including the power cables, source, etc.

The ATOC physical installation is described in detail in Section 1.

SCLDF Scoping Comment (8): Discuss impacts on sea turtles, fish and invertebrates.

Subsections on sea turtles, fish and invertebrates are included in both the environmental setting section (Section 3) and impact section (Section 4).

SCLDF Scoping Comment (9): Articulate a standard of significance, i.e. a standard of harm that will guide whether the transmissions continue. Identify who will implement the standard and make the decision whether to proceed with the project.

This presentation is included in Appendix C. The ATOC project is also suggesting the formation of a Community Advisory Group ("CAG") to interact with the program and advise on important decisions, including source termination decisions. The composition and structure of the CAG has not yet been developed, since it is anticipated that interested parties may wish to make proposals and suggestions regarding the CAG in their comments on the DEIS.

SCLDF Scoping Comment (10): Integrate the results of the baseline monitoring program into the EIS draft.

The MMRP baseline monitoring that has been performed to date is one of the many sources of information that has been relied upon in developing the analysis in the DEIS.

SCLDF Scoping Comment (11): Discuss the potential that the ATOC project will not work.

The challenges faced by the ATOC proposal are discussed in Section 1.

SCLDF Scoping Comment (12): Refine the "zone of influence" calculations.

The zone of influence calculations presented in the original permit applications to NMFS have been replaced with considerably more sophisticated parabolic equation models of the projected ATOC sound fields. Those sound fields are integrated with information about the distribution/abundance of marine animal species and the information available about the hearing abilities of those species to greatly refine the analysis of potential impacts.

SCLDF Scoping Comment (13): Include a cost/benefit analysis.

The environmental costs and benefits of the ATOC project are very speculative and subjective, and only a qualitative comparison is possible. To the extent that such a comparison can be made, the DEIS attempts to do so.

SCLDF Scoping Comment (14): Address areas of incomplete or uncertain information.

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Your comments point to the requirement of NEPA that where there is inadequate information on an impact, and the means of obtaining the information are not known, the EIS is to include: (1) a statement that such information is incomplete or unavailable, (2) a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment, and (4) the agency's evaluation of such impact based upon theoretical approaches or research methods generally accepted in the scientific community. HEPA includes a similar, although less detailed, requirement. The EIS responds to these requirements throughout, wherever there is a lack of information pertinent to an important issue. See also Section 6.4.

SCLDF Scoping Comment (15): Include a worst case analysis.

As you know, worst case analyses are no longer required under NEPA and have been replaced by the uncertainty disclosure just discussed. In any event, the presentation in the original NMFS permit application is similar to (and in fact much more extreme than) the worst case analysis requirement previously urged under NEPA. See DEIS Section 4.

SCLDF Scoping Comment (16): Describe the rationale behind selecting the ATOC source frequency, as compared to ultrasound frequencies.

Section 2 addresses this question. Low frequency sounds propagate much better than higher frequency sounds over long distances in the deep sound channel.

SCLDF Scoping Comment (17): Evaluate whether the MMRP will provide meaningful data, particularly regarding long-term impacts; justify the MMRP methodology.

The MMRP research protocols are presented in Appendix C of the DEIS, and include a discussion of the rationale for and limitations of those protocols. Long-term impacts are the subject of a separate subsection for each of the categories of marine animals evaluated in Section 4.

SCLDF Scoping Comment (18): Discuss the rationale for permitting research takes of sea turtles and sperm whales where they will not be a specific target of research.

The MMRP has been revised so that sea turtles and sperm whales will now be specific targets of research under the MMRP.

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SCLDF Scoping Comment (19): Discuss the techniques and impacts of the proposed whale tagging.

Whale tagging will not be done in connection with the Kauai MMRP.

SCLDF Scoping Comment (20): Discuss the arrangements for control of the sound source operations.

Control of the sound source operations is addressed at several locations in the DEIS, including Section 1, which addresses the relationship between the MMRP and ATOC feasibility operations, and in Appendix C, which discusses the detailed control of the source, including termination guidelines.

SCLDF Scoping Comment (21): Describe the MMRP's capabilities for monitoring behavior of animals at depths comparable to the source.

This issue is addressed in Appendix C, which includes a matrix chart showing the capabilities of each of the techniques included in the MMRP.

SCLDF Scoping Comment (22): Describe how ocean temperature measurements will be used and whether the results of this program guarantee governmental actions to curb emissions of greenhouse gases?

There is obviously no guarantee that future governmental actions will respond to the information developed by the ATOC project, but it is hoped and anticipated that they will. The role of the ATOC project in relation to global climate modelling efforts is addressed in Section 1 of the DEIS.

SCLDF Scoping Comment (23): Discuss the effect of the sources of funds (i.e. ARPA) on ATOC decision making and the potential for use of the project for military purposes.

There is absolutely no potential for use of the project for military purposes. Required ARPA approvals for ATOC activities are discussed in Section 1.

SCLDF Scoping Comment (24): Evaluate a variety of ATOC transmission protocols that minimize impacts on marine mammals.

The DEIS includes this analysis in Section 2.

SCLDF Scoping Comment (25): Discuss the consistency of the ATOC project in Hawaii with applicable plans, policies, and controls, including the Humpback Whale Recovery Plan, as well as the Humpback Hawaiian Islands Humpback Whale National Marine Sanctuary.

This is the subject of Section 5 of the DEIS.

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SCLDF Scoping Comment (26): Permit 813 does not cover the proposed playback studies and it should not be revised to include those studies.

NMFS published notice of receipt of an application to modify permit 813 on November 8, 1994. 59 Fed.Reg. 55639. Comments on the appropriateness of this permit should be made in that context. The modified permit requested does not differ significantly from the original permit, issued in February 1993. Research contemplated by that permit was not done, and the modification would extend the term of authorization for the research. The request to "take" 100 sperm whales has been deleted from the modification request. At the request of NMFS, the modification names several other species which may be affected by the experiment because they are within the two kilometer zone of influence. This does not represent a change in the originally authorized project, but merely provides documentation of potential effects originally contemplated. The DEIS will include a brief discussion of the playback studies and their impacts, including cumulative impacts.

Activities dependent upon modification of permit 813 will not proceed until the modified permit has been issued.

SCLDF Scoping Comment (27): Greater efforts need to be made to involve the public and concerned environmental groups in the environmental review process, including additional public hearings.

We understand that NMFS intends to hold an additional public hearing in February on the DEIS and the SRP. A principal purpose of the DEIS is to disclose important information about the project and its potential environmental impacts, and to provide a forum for public comment. The ATOC office has also attempted to keep interested parties informed through implementation of an ATOC hot line, and through periodic information bulletins to the public and press releases.

In sum, the authors of the DEIS have carefully reviewed your scoping comments and have made every effort to integrate and address them in the document. We trust that you will participate in the public review of the document and provide us with the benefit of your comments.

Sincerely,

Andrew Forbes
ATOC Program Manager

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SCRIPPS INSTITUTION OF OCEANOGRAPHY

LA JOLLA, CALIFORNIA 92093

December 18, 1994

Rex D. Johnson
Director of Transportation
589 Punchbowl Street
Honolulu, HI 96813-5097

Re: DLNR CDUA # KA-2734, Acoustic Thermometry of Ocean Climate and Marine Mammal Research Program

Dear Mr. Johnson:

Thank you for your response to the consultation notice on the above project. We will keep your department advised of any changes in the project which could have any effect on commercial harbor facilities or operations.

Sincerely,

Andrew Forbes
ATOC Program Manager

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LA JOLLA, CALIFORNIA 92093

December 18, 1994

Sam Lee
Division of Land Management
Department of Land & Natural Resources
3040 Eiwa Street, Rm. # 308
Lihue, HI 96766-1875

Re: DLNR CDUA # KA-2734, Acoustic Thermometry of Ocean Climate and Marine Mammal Research Program

Dear Mr. Lee:

Thank you for your response to the DLNR consultation notice on the above project. We will keep your division advised of any changes in the project which could affect division responsibilities.

Sincerely,

Andrew Forbes
ATOC Program Manager

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CORNELL LABORATORY *of* ORNITHOLOGY
159 SAPSUCKER WOODS ROAD • ITHACA, NEW YORK 14850

BIOACOUSTICS RESEARCH PROGRAM • (607) 254-2408 • FAX (607) 254-2415

December 14, 1994

Dr. William Fox
National Marine Fisheries Service
1335 East-West Highway
Silver Spring, MD 20910

Dear Dr. Fox,

I am writing this letter in response to the 7 December, 1994 letter addressed to you from Heller, Ehrman, White and McAuliffe, a firm representing the Marine Mammal Fund and the Earth Island Institute. That letter takes issue with Dr. Adam Frankel's request for a third modification to his permit #813; a permit granted almost two years ago to conduct acoustic playback experiments with humpback whales off the Islands of Hawaii. The modification was made in order to list other marine mammal species that might be exposed incidentally to the playback sounds during the proposed experiments. The primary reasons why I am writing a response are threefold: firstly, Dr. Frankel is now a post-doctoral Fellow in my lab at the Cornell Laboratory of Ornithology, and, as one of the team leaders in the Marine Mammal Research Program (MMRP) for Kauai, it is important that you understand the value of his permit #813 toward the goal of understanding the potential effects of low-frequency sounds on humpback whales. Secondly, I wanted to articulate the plan and rationale for the playback research that we propose to conduct this winter off north Kauai. Thirdly, I wanted to generally address some of the errors as stated in the Heller, Ehrman, White and McAuliffe letter especially as they relate to the MMRP associated with the oceanographers' Acoustic Thermometry of Ocean Climate project.

Let me proceed by first briefly stating motivations, where I believe I speak for all the marine mammal scientists who have dared venture into the thicket of emotion, scientific ignorance, and distrust that has been unlocked by the acoustic thermometry project. The primary motivation is simple. We are committed to learn and teach about marine mammals in order to expose not only their special place in the natural world but also their broader place in the ocean's ecosystems. We do this through the scientific method, and we are inspired by our individual commitments to understand, protect, and conserve the ocean and all its life forms. Under the scientific process, we make progress based on the accumulation of facts, the use of logic, and hypothesis testing. An absolutely essential underpinning of this process is scientific integrity and independence. Although, as scientists, we may often disagree

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on the strengths of various methodologies, interpretations of results, and scientific priorities, we always respect each other's independence and debate those differences within a forum of trust. Thus, it is particularly disturbing when that integrity is discarded, when facts are ignored or misused, and when emotion and ignorance are given equal weight to logic and knowledge.

In a nutshell, that's what has been happening in this firestorm in which marine mammals are the emotional fuel and the acoustic thermometry project is the lightening rod. Those of us with knowledge of, but also with deep commitment to, the ocean and its inhabitants are being labeled as the devil's disciples by those triggered into action more out of passion and misinformation than out of reason (but often good intentions). Many of us as individuals have attempted to stand up to this irrational assault, but because the discussions are not based on logic or facts there is no progress and resolution, just more unjustified accusations. It is time that something bigger than an individual stand up to this nonsense and clearly draw the line. It is time that NMFS take a stand and respond with authority to the kinds of accusations, stated and implied (as exemplified by the letters from Heller, Ehrman, White and McAuliffe, the Honorable Patsy Mink's office, and Sierra Club Legal Defense Fund), that tend to push the animals we are trying to protect further out of the picture while making improved decisions more difficult. One key purpose of the scientific permit process was to protect the animals and assure that the research benefited their future well being. That is precisely why we have proposed playback experiments off north Kauai. It is the single most powerful scientific method we have to answer the complex question on the potential effects of low-frequency sounds on free-ranging marine animals. Playback experiments are the empirical basis for almost all our predictions on such effects, and the experiments proposed under permit #813 are certainly of no direct scientific benefit to the oceanographers.

The Kauai MMRP plan

At present, our understandings of the potential effects of low-frequency, human-made sounds on the endangered humpback whale are poor. They are primarily based on empirical studies on vessel-humpback interactions conducted in southeast Alaska, or by comparative extrapolation from playback studies conducted either on gray whales off central California or on bowhead whales in the Beaufort Sea. There are no systematic data documenting how humpbacks respond to low-frequency oceanographic research sounds such as the type proposed by the Acoustic Thermometry of Ocean Climate project. In that project, as you know, a world-class team of oceanographic scientists propose to use a specially designed acoustic signal (a 75 Hz center frequency, 35 Hz bandwidth, coded m-sequence of ca. 27 seconds duration repeated 42 times over 20 minutes) at 195 dB (re 1 µPa, the underwater reference standard), for 20 minutes with a preceding 5-minute ramp-up period, from a depth of 850 m. Two years ago, working in conjunction with Adam Frankel (at the time a student of Dr. Louis Herman of the University of Hawaii), we proposed to Scripps Institution of Oceanography to do acoustic playback experiments to humpbacks off Hawaii. The logic was simple; playback is a powerful technique for exposing the potential impacts of human-made sounds on whales, we both had

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experience with the technique (Adam on humpbacks, me on right whales and gray whales), and there was multi-year baseline data available from the Kona coast of the Big Island. Adam therefore submitted a permit application. It was granted (#813), but the proposed research was not funded. Now after collecting two seasons' worth of baseline data for the north Kauai site, the application of the sound playback method is timely and logical. What we have proposed to Scripps is a playback paradigm that is very similar to the one used for the gray whale playbacks off central California. The results of that research, where the biological team was co-led by Dr. Peter Tyack of the Woods Hole Oceanographic Institute and me, are the primary source of the 120 dB (re 1 μPa) level so frequently cited as the level above which animals should not be exposed. This 120 dB is a number that comes with a list of caveats, not the least of which is that we don't know what the gray whales were responding to other than the presence of a sound source in the middle of their migratory corridor (i.e., was it just in the way so they swam around it, or was it really disturbing?). One of our goals for the Kauai experiments is to playback a low-frequency sound modeled after the sound that the acoustic thermometry project proposes to use for its research on ocean climate. We plan to use the best transducer we can rent (a J15-3) so that we can determine whether or not a whale responds to the received sound level, the signal-to-noise ratio (how loud the sound is compared to background noise), the rate of change in the sound field, or its proximity to the source. All these results will be placed in the natural context of what the whale was doing at the time (e.g., traveling, singing, resting, socially active). From the past two seasons' results, gathered using a combination of proven observation techniques (aerial, acoustic, and shore-based) by a team of some of our country's leading marine mammal scientists, we know that we can already observe subtle reactions of the whales to existing human-made activities. Therefore, we are quite certain that we will be able to statistically test for differences in the reactions of the whales under control and playback conditions, and place those responses in a proper context. The playback vessel will be stationary, moored in 100 m of water, with the transducer at 50 m. The maximum output of the source is 176 dB (re 1 μPa). At this level the sound is 1% of the level proposed by the acoustic thermometry project (2.6 Watts versus 260 Watts), and is of absolutely no use for their oceanographic research. However, the maximum level is high enough (about ten times greater than the maximum level in the gray whale playback experiments) to allow us to differentiate between a whale's responses to such things as received level and sound gradient. In conjunction with the behavioral observations under controlled and experimental conditions, we will collect empirical data on the sound field as generated by the playback and ambient noise levels in the study area. These critical data will be the basis for associating our observations with the physical conditions of the playback exposure. This is one area where a planned collaboration with the ocean scientists with expertise in modeling sound fields and acoustic propagation will greatly benefit our biological results, since we will be able to compare our empirical data with the most up-to-date sound propagation models in order to better determine exactly what the animals were exposed to.

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As already stated, this playback experiment is of no direct value to the proposed Acoustic Thermometry of Ocean Climate project, but its results will be very valuable for better understanding the potential effects on humpbacks of the low-frequency sounds that project proposes to use. Given that there is already a plethora of human-made sound sources in the oceans and that these are certainly louder and more persistent than the proposed Acoustic Thermometry of Ocean Climate project source, it would seem wise to begin conducting some research that specifically addresses the issue of potential low-frequency sound impact on marine mammals. Otherwise, if we are going to rely on the few bits of information (e.g., the 120 dB re 1 µPa gray whale threshold) that are insufficient, we are not making progress on behalf of the animals. The combination of the urgent need to know more about this problem, the level of resources that the Acoustic Thermometry of Ocean Climate project is willing to devote to marine mammal research, and the scientific value of that effort, would all argue strongly in favor of issuing an extension of Dr. Frankel's existing permit #813.

Before closing, I should add that other related projects are being planned. We want to conduct another set of inter-island surveys this winter (under Dr. Mobley of the University of Hawaii, permit #810). The logic there is that similar surveys were conducted two years ago, and we need to begin to build a baseline of such data in order to document population abundance estimates for the wintering Hawaiian humpbacks, and to document changes in those estimates and distributions over time in order to evaluate long term trends that might be associated with human-made activities such as the Acoustic Thermometry of Ocean Climate project.

We also plan to support Drs. Paul Nachtigall and Whitlow Au of the University of Hawaii to investigate the listening thresholds of three species of odontocete (a bottlenose dolphin, a Risso's dolphin, and a false killer whale) for the low-frequency, acoustic thermometry 75 Hz m-sequence.

For non-Kauai sites, research projects on sperm whales and sea turtles are under active development. In Dr. Frankel's permit #813 modification he requested authorization to conduct playback experiments to as many as 100 sperm whales. Given that all our data for north Kauai reveal that sperm whales are scarce, we have decided in September not to conduct sperm whale playback work off Kauai. Instead, a sperm whale research plan is being developed in collaboration with Dr. Jonathan Gordon of Oxford University, England (and the International Fund for Animal Welfare). The plan is to conduct a series of playback experiments, similar to the ones described above for humpbacks, with sperm whales off the Azores, using m-sequence sounds with center frequencies of 800, 400, 200, and 75 Hz.. The Azores site offers many advantages. It is Dr. Gordon's field site, so there are good baseline data, and the prospects for obtaining good sample sizes in a single season are very good. Dr. Gordon is an excellent scientist and one of the world's leading sperm whale specialists. The project on sea turtles and the potential impact of low-frequency sounds on these endangered animals is more problematic because there is a paucity

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of research on turtle behavior, especially in the area of acoustics. Nonetheless, I am working with Dr. Scott Eckert of Hubbs SeaWorld Research Institute to find a way to conduct meaningful research on these animals.

I hope this has helped define the motivations of the Marine Mammal Research Program for Kauai as well as my concerns, visions and plans. I realize that this entire matter has required an unusual amount of your offices' resources. Let us hope that all our efforts lead to both an improvement in our understandings of marine animals and the impacts of our activities on them, as well as an improvement in the mechanisms for protecting the environment in which they must survive.

Sincerely,

Christopher W. Clark, Director
Bioacoustics Research Program

/Cg:Permit

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA 92093

December 7, 1994

Denis R. Lau, Chief
Clean Water Branch
Department of Health
P. O. Box 3378
Honolulu, Hawaii 96801-3378

Dear Mr. Lau:

Thank you for your letter of October 13 concerning the Acoustic Thermometry of Ocean Climate (ATOC) project which the University of California, Scripps Institution of Oceanography (Scripps) proposes to implement off the north shore of Kauai. As you suggested, we have made further contact with Mr. Edward Chen of the Department's Clean Water Branch Engineering Section through a phone call by our legal counsel, Mary Hudson.

In response to these communications, and after consultation with counsel, I would like to provide several points of clarification. First, I want to clarify that we do not anticipate that the ATOC project will involve a permit under § 404 of the Clean Water Act. Section 404 does not apply outside the three-mile sea. The only portion of the project facilities within the three-mile limit is a portion of the power supply cable along the west and northwest side of Kauai.[1] This power transmission cable requires no fill or bedding activities, and is simply laid along the surface of the seabed without alteration of existing contours.

The § 404 regulations define "fill" as "any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a water body." § 33 C.F.R. § 323.2(e). Under these regulations, "discharge of fill material" means "the addition of fill material into waters of the United States ... [including] ... [p]lacement of fill that is necessary for the construction of any structure in a water of the United States." 33 C.F.R. § 323.2(f).

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1 Since our August 29 letter to the Corps of Engineers, it has become clear that the Center for Excellence for Research in Ocean Sciences ("CEROS") project, which will involve placement of hydrophones with a cable connection to shore near Hanalei, will proceed entirely separate from the ATOC project. The CEROS project sponsors will independently undertake regulatory compliance activities. ATOC may seek to use the CEROS hydrophones if they are in place when ATOC operations commence. Otherwise, ATOC will use buoyed autonomous hydrophones.

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The Corps of Engineers, Honolulu District, has advised us that placement of the ATOC power cable without any alteration of the seabed is not considered by the Corps to be a discharge of fill under the Clean Water Act and does not require a § 404 permit.[2] This advice is consistent with the Corps' long-standing policy that placement of certain structures for which neither the effect, purpose, nor function is equivalent to fill, do not constitute discharge of fill within the meaning of §404.[3] See Corps Regulatory Guidance Letter No. 88-14 concerning applicability of § 404 to placement of piles and other structures (copy enclosed).[4]

This Corps policy is also reflected in the terms of Nationwide Permit ("NWP") 12 for utility line (including cable) back fill and bedding. NWP 12 applies to "discharges of material for backfill or bedding for utility lines ... provided there is no change in preconstruction contours."[5] NWP 12 further provides that "[t]he utility line itself will require a Section 10 permit if in navigable waters of the United States." 33 C.F.R. App. A (B) (12). NWP 12 thus recognizes that laying of the cable itself is not subject to § 404.

Because there is no backfill or bedding for placement of the ATOC cable, NWP 12 does not apply. However, as NWP 12 notes, laying of the cable is subject to the § 10 program. Accordingly, our intention to use the appropriate § 10 general permits as reflected in our letter of August 29 to the Corps.

In the absence of a § 404 permit for the ATOC project, we know of no basis for applying the water quality certification requirements of § 404 of the Clean Water Act.

Mr. Chen has raised the question of whether the State's § 401 certification process would apply based on the § 10 permits or upon some other basis. Our counsel has advised us that it does not apply, for the reasons described below.[6]

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2 In the California ATOC project, where the cable is also to be simply laid on the seabed, the San Francisco District, Corps of Engineers, has provided the same advice.

3 Power transmission lines are included in the Corps' definition of "structures." 33 C.F.R. 333.2 (b).

4 Mr. Chen has requested that we request additional verification from the Corps on this point, and we will do so.

5 33 C.F.R. App. A (B) (12).

6 We note that the State's § 401 Water Quality Certification Guidelines, at p. 3, list common federal permits which may require § 401 certification, but do not include § 10 permits, which the Corps commonly issues for placement of structures in navigable waters.

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Department of Health
December 7, 1994
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Under § 404 of the Clean Water Act the state water quality certification process applies in connection with any application "for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters ... " 33 U.S.C. § 1341 (1). The ATOC project does not meet this threshold requirement for § 404 review.

First, under the Clean Water Act, "navigable waters" is defined to mean "the waters of the United States, including the territorial seas." 33 U.S.C. § 1362(7). The term "territorial seas" is defined, in turn, to include the area from the line of ordinary low water seaward a distance of three miles. 33 U.S.C. § 1362 (8). Thus the only element of the ATOC project within the geographic scope of § 404 is a portion of the power transmission cable.

Second, the project will not result in any discharge cognizable under the Clean Water Act. The Act defines "discharge of a pollutant" to mean (a) addition of a pollutant to navigable waters from a point source, and (b) addition of a pollutant to the Territorial Sea as defined under the Convention on the Territorial Sea (200 miles) from any point source other than a vessel. 33 U.S.C. § 1362 (16). "Pollutant" is defined by the Act[7] and does not include any matter introduced into the water through installation or operation of the ATOC facilities.

The Act also provides a partial definition of the term "discharge" when used without qualification.[8] Neither this definition nor any other aspect of the Act provides support for the view that placement of a structural facility such as a power cable constitutes a discharge. On the contrary, § 401 distinguishes between a discharge and a facility which may make the discharge: "Any applicant for a Federal license ... to conduct any activity including ... construction or operation of facilities which may result in any discharge ... " If a facility will not result in any discharge, the Act provides no basis for treating the facility itself as a discharge.

The authority for the State to undertake § 401 review must arise, if at all, on the basis of the federal Clean Water Act. We can identify no legal basis in that Act for § 401 certification authority in relation to the currently proposed ATOC activities.

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7 "The term 'pollutant' means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." 33 U.S.C. § 1362 (16).

8 "The term 'discharge' when used without qualification includes a discharge of a pollutant, and a discharge of pollutants." 33 U.S.C. § 1362 (16).

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Even if the § 401 program were to apply, we believe that waiver of the certification process would be warranted based upon the absence of any risk of pollution or alteration of the marine environment from ATOC facilities within navigable waters covered by § 401 and upon the project's consistency with all applicable state water quality standards.

To enable your evaluation of these points, we are providing you with additional information about the project. Enclosed are the following items:

1. Illustration of ATOC cable route,

2. Copy of the draft version of the Coastal Consistency Certification request. This request, which has been submitted for an informal review and will be formally submitted upon completion of the Draft EIS, includes a summary description of the overall ATOC project,

3. Final Survey Report for the Kauai Acoustic Thermometry of Ocean Climate Site, prepared by Seafloor Surveys International, Inc. (SSI), for the Applied Physics Laboratory of the University of Washington (1993).

The SSI report reflects two bathymetric surveys utilizing side-scan sonar equipment to identify and map the cable route. The survey data is reflected in detailed sailing sheets and geological descriptions, which are included in the report.

The route identified in the SSI report was followed when the cable was laid, in October 1993, by the USNS *Myer*.[9] The route originates at a preexisting cable junction box 1.3 kilometers offshore at the Pacific Missile Range Facility, Barking Sands, and runs approximately 51.1 km around the northwestern side of Kauai to the proposed sound source site, on the seabed approximately 14.7 km north of Kailiu Point. Approximately 36.3 km of the cable is within the three-mile seat subject to § 404 jurisdiction.

As indicated in the report, the shallowest location of the cable is at the junction box offshore Barking Sands, at a depth of 24 meters. The cable runs in a northwesterly direction around the island at depths ranging between 73 and 108 meters, terminating at a depth of 810 meters, where it will eventually be connected to the sound source. (See SSI report, Table 1. The report describes two possible source sites; "Site 1," the western route, was chosen.)

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[9] This portion of the project was carried out by the Navy, which owns the cable

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The cable is a type SD List 1 (nominally 2.5 cm diameter), coaxial, twin conductor, insulated cable. Its installation involved no trenching, bedding, fill, or other alteration of seafloor contours. The cable was placed from aboard the Myer, using a GPS navigation system to direct its placement in accordance with the SSI data. The cable was laid using standard cable laying procedures, involving the streaming of the cable (under minimal tension) over the stern of the ship and allowing the cable to settle onto the ocean floor.

As the SSI report shows, the cable route avoids reefs, canyons, and steep slopes. It was considered important to run the cable over a stable and relatively flat seabed, avoiding areas prone to sediment flows and cable suspensions which could result in stress and breakage. (See SSI report pp. 4-5, 21-30.) The cable route crosses the offshore reef seaward of the junction box along surge channels identified in the SSI report. (Pp. 21-24.) No other reef crossings are involved. As indicated at several places in the report, because the cable route is laid on relatively flat or gently sloping bottoms, much of the cable will soon be covered by mobile sand. (See pp. 22-23, 25.)

We have considered this cable installation in light of state water quality standards for marine waters and marine bottom ecosystems, as well as the standards of general applicability, Haw. Admin. Rules Title 11, Ch. 54. The cable installation involves no degradation of water quality and is thus consistent with the general policy of § 11-54-01. The project involves none of the pollutants prohibited by § 11-54-04. Its relationship to specific standards is considered below.

All portions of the cable fall within the classifications of § 11-54-06 (b) as "open coastal waters" (shore to 183 meters, excluding embayments) or § 11-54-07(c) as "oceanic waters."[10] The designation of open coastal waters between Hikimoe Valley and Makahoa Point as Class AA [§ 11-54-06 (b) (A) (vii)] takes in most of the cable route, excluding the small segment from Barking Sands to Hikimoe Valley and the deep area of the northern terminus.

Section 11-54-03 (c) of the water quality standards states the objective that Class AA marine waters remain in their natural pristine state as nearly as possible, with an absolute minimum of pollution or alteration of water quality. The ATOC cable, involving no pollution or alteration of water quality, is compatible with this objective. Among the uses protected in Class AA waters is oceanographic research. Use of the cable to transmit power is part of the ATOC oceanographic research activities.

In addition, other uses are expressly allowed in the Class AA area, provided they conform with applicable criteria as wells as the Class AA objectives. Criteria applicable

[10] No "embayments", as defined at § 11-54-06, are involved.

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to all waters appear at § 11-54-04. However, these deal with specific types of pollution and specific pollution effects, none of which are even arguably attributable to the cable or any other aspect of the ATOC project. Similarly, the criteria of § 11-54-06 (b) (3) deal with pollution factors which have no applicability here.

Thus the ATOC cable installation is consistent with all restrictions applicable to Class AA waters. The project is similarly consistent with standards for Class A and Oceanic waters, which are less restrictive.

Of the marine bottom types identified in § 11-54-07, only the "soft bottom communities" occur along the cable route. All of the reef flats and communities identified in the standards occur at depths much shallower than the cable route.

The regulatory definition places "protected reef communities" at depths of 10 to 30 meters and "wave-exposed reef communities" at depths of up to 40 meters. § 11-54-07 (e) (1). The SSI report indicates that the cable route from its shallowest point at the junction box near Barking Sands runs along sandy and coral rubble bottom which extends to a depth of 28 to 30 meters. Seaward of the coral ruble under the junction, the cable route crosses a gentle sandy slope (<1%) from approximately 1400 to 2200 meters offshore. In water depths of 45 to 67 meters, the cable route crosses the irregular outer face of the outer reef. (SSI report pp. 21-22.) The outer reef does not fall within the regulatory definition of "wave-exposed reef communities" (depths up to 40 meters).

Even though the cable route contains none of the reef flats or communities having Class I or Class II status under § 11-54-07 (e) (2) (A) (i) and (ii), it maybe noted that for reefs near the cable route, no sediment deposits proscribed by § 11-54-07 (e) (3) are involved and no substantial risk of damage, impairment, or alteration of the biological characteristics of reef communities exists. The presence of the power transmission cable is an entirely passive and nonconsumptive use involving no alteration of the seafloor, and is thus consistent with § 11-54-04 (d) (1).

The SSI report indicates the presence of soft bottom areas along the cable route. The standards treat soft bottom communities as Class II areas. In such areas, whether soft bottom or Class II reef areas, § 11-54-03 (d) (2) allows uses which do not permanently or completely alter or degrade marine bottoms. The cable installation is consistent with this requirement and with the oxidation-reduction restrictions of § 11-54-07 (f) (3).

As the foregoing information indicates, the cable installation, because of its nature and location, raises no issue of conflict with any of the State's water quality standards which could have applicability in § 401 certification review.

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We have also considered the Hawaii Revised Statutes' definition of "water pollution" (§ 342 D-1) cited in your letter and its effect upon regulatory review of this project. As noted, the question of whether § 401 review applies is determined upon the basis of federal jurisdictional standards, and federally approved substantive standards are applied by the state in § 401 certification.

Apart from § 401 review, we anticipate that the Department will be involved in project review being carried out by other state and federal agencies.[11] We are mindful of concerns about the possible effect of ATOC's low-frequency sound transmissions upon aquatic life. That issue will be the subject of a six-month research program (the marine mammal research program, "MMRP") which will be carried out as part of the ATOC project but before commencement of acoustic transmissions related to ocean climate research. The latter research program will be tailored to avoid any adverse effects identified by the MMRP.

We expect these issues to be actively addressed in the context of Scripps' pending application to the Department of Land and Natural Resources for a conservation district use permit and Scripps' federal consistency certification soon to be submitted to the state Coastal Zone Management Office (we have enclosed a copy of an informal draft version of this document to assist you in your review). Both state review processes will encompass the full scope of project facilities and activities, including those outside the federally recognized territorial sea. In addition, these issues are being addressed through Scripps' application to National Marine Fisheries Service for a scientific research permit and through consultation with the National Marine Fisheries Service under § 7 of the Endangered Species Act.

We anticipate that the Department of Health and the various authorities it implements will be involved in project review being carried by these other agencies. In particular, we understand that the Department, as one of the Hawaii Coastal Zone Management Program network agencies, will take part in federal consistency review.

We had planned to be able to respond to your letter with inclusion of the draft state-federal environmental impact statement, which would have provided much of the background included in this letter and other information concerning the project. Because delays have pushed the release date of the DEIS to the beginning of next year, we are responding now and will provide you a copy of the DEIS as soon as it is available. Time is critical for this project because of the long lead times necessary for regulatory review and the need to carry out the marine mammal research during the seasonal presence of the Humpback whales in Hawaiian waters.

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[11] Based on our discussions with Mr. Chen, we understand that in the absence of § 401 certification, the Department undertakes no direct water quality regulation, but participates in review of a project through other state agency review processes.

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Denis R. Lau, Chief, Clean Water Branch
Department of Health
December 7, 1994
Page 8

We are hopeful that the information we have provided will adequately clarify the inapplicability of the § 401 certification provisions to the cable installation. If you would like to discuss the matter further, please contact me at the earliest possible date at 619/534-5671 or Mary Hudson at 510/465-4494.

Sincerely,

Russ Albertson
for Andrew Forbes
ATOC Program Manager
Scripps Institution of Oceanography

cc: Edward Chen, Clean Water Branch, DOH

without enclosures
Lt. Colonel Bruce Elliot, Dist. Engineer, Honolulu Dist. COE
Mike Lee, Honolulu District, COE
Calvin Fong, San Francisco District, COE
Dr. William Fox, Director, Office Protected Resources, NMFS
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Douglas S. Y. Tom, Chief, Hawaii CZM Office

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Denis R. Lau, Chief, Clean Water Branch
Department of Health
December 7, 1994
Page 9

bcc: (without enclosures)
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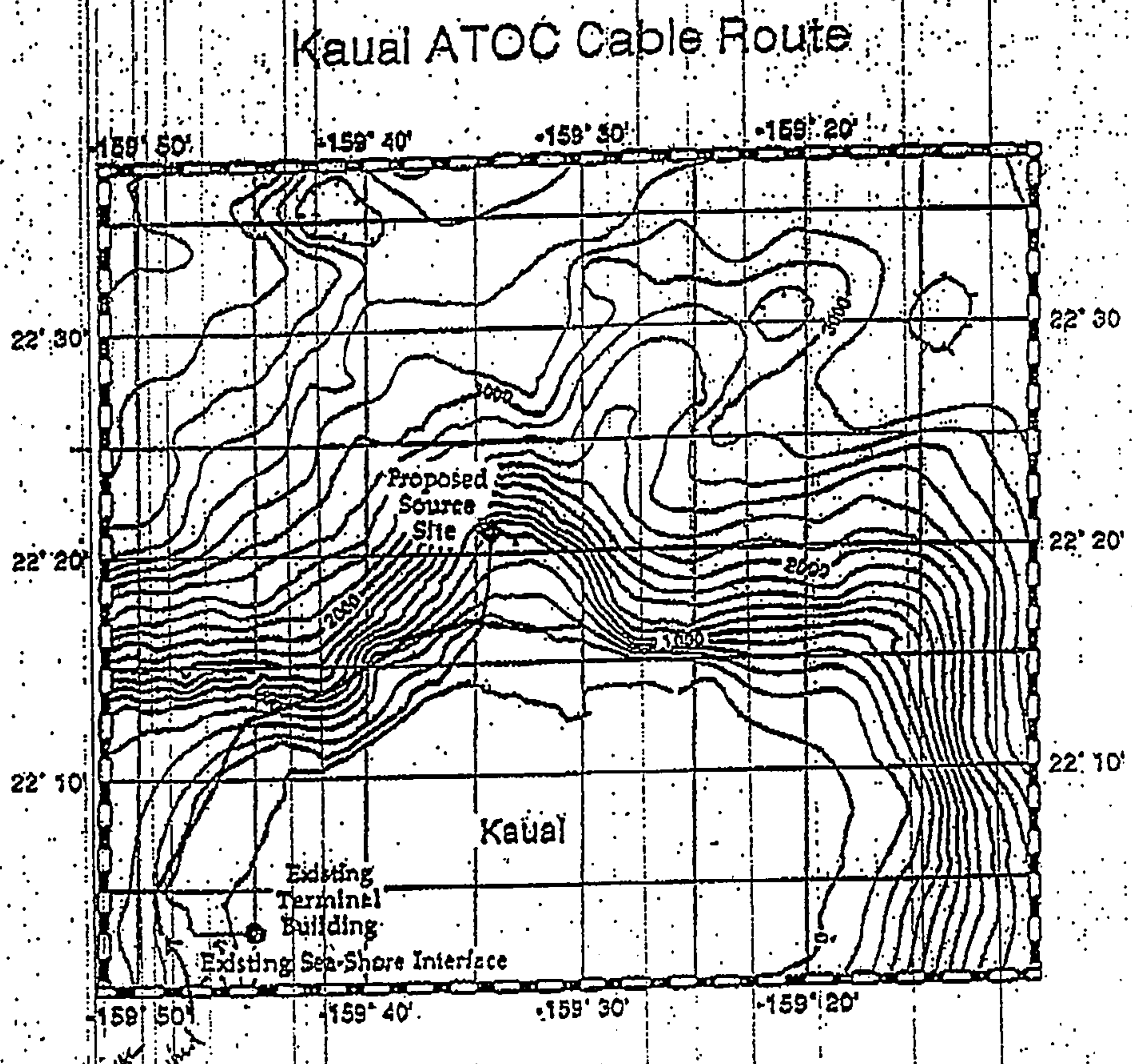

Figure 1 - Proposed Kauai Cable Route and Source Site

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VIA FACSIMILE

November 8, 1994

Paul Achitoff
Sierra Club Legal Defense Fund, Inc.
223 South King Street, Fourth Floor
Honolulu, HI, 96813
FAX: (808) 521-6841

Re: Scripps Acoustic Engineering Test

Dear Mr. Achitoff:

I represent the University of California, including the Scripps Institution of Oceanography (Scripps) in connection with several matters including the upcoming acoustic engineering test (AET) to take place approximately 300 miles offshore Baja California. This letter responds to your November 4, 1994, letter regarding AET, sent to the Advanced Research Projects Agency (ARPA), National Marine Fisheries Service (NMFS), and Scripps.[1]

Your letter: (1) objects to the public notice that has been provided of the AET, (2) urges that the AET be delayed for approximately 30 days to permit public comment on the finding of no significant impact (FONSI) for the AET, which was signed before your letter was transmitted on November 4, (3) argues that a programmatic EIS is required before the AET can proceed, and (4) suggests that violations of the Endangered Species Act (ESA) and/or the Marine Mammal Protection Act (MMPA) may occur if the AET is carried out without a permit from the NMFS. Scripps has requested that I respond to each of these points. We also understand that ARPA may be preparing a response later in the

[1]The letter was transmitted by facsimile after the close of business last Friday so we were unable to begin preparing a response until Monday. The copy received by Scripps also has an apparent transmission error that has blacked out a small portion of each page. While most of your points are readable, I would appreciate receiving a clean copy to ensure that all issues have been addressed.

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week, but that your letter arrived at a time when key personnel were unavailable, precluding an immediate response.

Public Notice of the AET

ARPA, NMFS and Scripps have attempted to keep interested parties informed of these activities. As you note, the AET was first announced to concerned environmentalists at a meeting in San Francisco, soon after it was proposed in July, 1994. Representatives of environmental organizations, including your organization, the Sierra Club Legal Defense Fund (SCLDF), as well as several of your clients as listed in your letter, were in attendance at that meeting.

The only response to that announcement, to our knowledge, was an August 11 letter from Heller, Ehrman, White & McAuliffe (Heller) in San Francisco to NMFS, on behalf of the Natural Resources Defense Council, Earth Island Institute and the Marine Mammal Fund, requesting review of whether a permit would be required for the AET under the Marine Mammal Protection Act (MMPA) or Endangered Species Act (ESA). Although neither Scripps nor ARPA were included on the distribution list for that letter, NMFS forwarded a copy to ARPA and requested that ARPA address the issues raised in it.

In response, ARPA provided an analysis to NMFS, and requested confirmation from NMFS in a September 8 letter of the conclusion that no "taking" of marine mammals would occur during the AET. On October 21, NMFS provided a response, conditioning its confirmation that no taking would occur on several measures, including the termination of sound transmissions when an animal is detected within the "zone of modified behavior" (10-15 km, depending upon the site, based upon the 120 dB sound field contours), rather than a 2 km zone that Scripps previously had proposed. This mitigation has since been incorporated into the AET proposal.

Until your November 4 letter (and a letter that same day from one of your clients, Kauai Friends of the Environment), no party requested an environmental assessment (EA) for the AET, nor an opportunity to comment on an EA for that activity. Moreover, no party requested any additional information concerning the timing or other details of the AET following the July announcement. In light of this, and given the fact that the AET will be conducted nearly 3000 miles from Hawaii in a area with very low marine mammal populations, will only involve approximately 20 total hours of ATOC transmissions over an 11 day period, and will have operational protocols whereby transmissions will not occur (or will be stopped) if a marine mammal is detected within the 120 dB "zone of modified behavior" around the

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sound source, we did not anticipate significant public controversy surrounding the project, particularly not from Hawaii organizations.

Since the AET will be undertaken in such a way that no "taking" of marine mammals will occur, no permits are required. Because of this, Scripps recognized that there would be no formal processes to provide a basis for community input. For that reason, Scripps circulated a project update on October 24, which you apparently received early last week, to provide more detailed information on this activity.[2] Scripps provided the update promptly after receipt of NMFS' October 21 letter. Scripps and ARPA also received several requests for information regarding the AET following the October 24 press release, and attempted to respond to all of those requests promptly.

As you note, the Department of Defense (DoD) regulations under the National Environmental Policy Act (NEPA) provide that DoD Components are to: "involve environmental agencies, applicants, and the public, to the extent practicable, in preparing environmental assessments. In determining 'to the extent practicable,' factors that may be considered include: a. Magnitude of the proposal, b. Likelihood of public interest, c. Need to act quickly." NEPA regulations at Section 1506.6 also provide guidance regarding public involvement.

Most of the forms of public involvement suggested in Section 1506.6 do not apply to remote locations. For example, Jasper Seamount is not in any state and has no nearby residents, newspapers or other local media. California and Hawaii are a considerable distance from the project site; nonetheless, notice was given there in a very expansive application of these public participation methods.

The public participation in the EA commenced at the earliest practicable date, soon after the AET was proposed, through announcement to environmental organizations that it was considered might be concerned with the proposal. Notice was given to environmental groups commencing with the July 19 meeting in San Francisco, and through media releases issued in both Hawaii and California on October 24. The one substantive comment received concerning the AET, that compliance with the ESA and

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[2]Your inflammatory accusations that Scripps withheld the October 24 update until after "discovery" of the information by your and/or your clients is patently false and defamatory. Scripps issued the update promptly after the pertinent information was available, specifically the October 21 letter from NMFS.

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MMPA be reviewed, was addressed through ARPA's September 8 letter and NMFS' October 21 response. ARPA involved NMFS in the EA process through the consultation reflected in this correspondence. Since NMFS is the principal agency responsible for regulating activities that might affect marine mammals, more extensive environmental agency involvement was unnecessary. ARPA also coordinated with the applicant, as directed by this guideline. Given the low magnitude of the proposal and the lack of material response to initial discussions with the environmental community, this level of public involvement was more than adequate from the standpoint of the NEPA and DoD regulations mentioned above.

It should be noted that one goal of the AET is to respond to comments previously submitted by SCLDF on March 17, 1994, requesting that Scripps actively seek out and develop alternatives to cabled sound sources in Kauai and California. The AET will evaluate the acoustic properties and marine mammal populations of a remote ocean site as requested by you and your clients, and will permit utilization of ATOC resources to analyze various technical and engineering questions presented by long-range acoustic thermometry, while accommodating a delay in commencement of operations in Kauai and California pending completion of the environmental impact statement (EIS) processes for those two proposals.

Had you or your clients registered their interest in the AET when first informed of it, ARPA, NMFS and Scripps could have responded. However, we cannot be held accountable for your delay in expressing a wish to participate until the eve of the experiment.

Request for a 30 Day Delay to Permit Comment on the FONSI

Your letter also requests a delay in the AET to accommodate a 30-day comment period on the EA and FONSI, claiming that NEPA guideline 1501.4(e)(2) triggers a comment period obligation. Your conclusion is incorrect. This short term test of a sound source in the ocean, at sound intensities comparable to commercial ships, at a location where marine mammals are relatively sparse, and given the operational protocols described in the EA, is not one (or similar to one) that would normally require the preparation of an environmental impact statement, nor is the activity without precedent, given these factors. Acoustic oceanography is an established and relatively common activity and the 260 watt source power levels to be utilized for the AET are not unprecedented and in fact are much lower than those used by several other experiments. This is not "an unusual case, a new kind of action, or a precedent setting case." Merely advancing knowledge in an area of scientific inquiry is not the type of

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novelty that triggers a 30-day review period.

Given the negligible level of impacts presented and the relatively minor and short term nature of the AET, there is no possibility of exceeding either threshold for preparation of an EIS -- this is not a major federal action and it will not significantly affect the environment.

If, however, you have additional substantive comments on the EA or the AET, Scripps (and I presume ARPA and/or NMFS) would appreciate receiving them promptly so that they may be considered.

Request to Delay AET Until Preparation of a Programmatic EIS

You have also requested that the AET be delayed pending preparation of a programmatic EIS on what you characterize as the "overall ATOC program." This request is based on an incorrect description of the ATOC project and misapplication of the NEPA guidelines.

The fundamental issue, which you simply assume in your letter to be true, is whether the AET and other ATOC activities are "connected actions" as defined under the NEPA guidelines. Actions are connected if they:

(i) Automatically trigger other actions which may require environmental impact statements.

(ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.

(iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

40 C.F.R. § 1508.25. Your letter cites only subsection (iii) and therefore (correctly) implies that subsections (i) and (ii) are inapplicable. In interpreting subsection (iii), the courts have applied an "independent utility" standard, requiring that: "The dependency is such that it would be irrational, or at least unwise, to undertake the first phase if subsequent phases were not also undertaken." <u>Blue Ocean Preservation Society v. Watkins</u>, 754 F.Supp. 1450, 1458 (D.HW. 1991). Under this decision, independent utility means utility "such that the agency might reasonably consider constructing only the [facility] in question." <u>Id</u>. at 1459.

The AET will provide useful information about a number of questions pertinent to acoustic oceanography in general and acoustic thermometry in particular. The oceans are largely

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transparent to sound and opaque to electromagnetic radiation. Any remote sensing of the ocean interior must therefore depend on sound transmissions through it, whether the goals are to study the behavior of marine mammal populations, to measure large-scale ocean temperature variability, in order to study geophysical processes occurring at mid-ocean spreading centers and undersea volcanos, to monitor for violations of the nuclear test ban treaty, or to remotely sense any of a number of other processes in the ocean or on the seafloor.

Proper interpretation of acoustic measurements, whether active or passive, requires a full understanding of acoustic propagation at the range of interest. While extensive basic research on acoustic propagation has been done out to ranges on the order of 1000 kilometers, much less fundamental research has been done on propagation at the longer ranges of importance to remote sensing of global scale processes.

In particular, little is known about the effects of ocean internal waves, eddies, and other oceanographic features on long-range acoustic transmissions. The AET is a basic research activity to provide the data needed to study these issues. With respect to acoustic thermometry in particular, the AET will begin to provide the basic data needed to evaluate the minimum source levels and duty cycles necessary, as well as to test the Alliant source technology at full operating depth. All of these goals have independent utility and would be an appropriate effort even in the absence of any other ATOC proposals, including but not limited to the proposed Kauai and California cabled installations. Far from committing the ATOC project to cabled sources in Kauai and/or California, if anything the AET is evaluating several questions regarding acoustic thermometry through alternate means, and is developing information about the acoustic properties of a remote site that will be useful in considering alternatives to near-shore installations.

Your conclusion that the AET will have impacts that cumulate with the proposed Kauai and California cabled sources also is unsupported and incorrect. First, as demonstrated by the EA, the AET will have negligible impacts and it is not a material cumulative source of noise at the proposed test site. Second, since the Kauai and California sources are not yet in operation, and there is no present plan for future AETs when those sources become operational, there are no direct cumulative impacts. Moreover, given the large distances between Jasper Seamount offshore Baja California and Sur Ridge, California or Kauai, Hawaii, AET sounds will be well below background at that range.

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Need for Permits Under the MMPA and/or ESA

Your letter also states that the AET "is courting violations of the MMPA and ESA." You argue that the AET will "obviously harass" marine mammals including sperm whales. Yet, as you know, NMFS, as the federal agency primarily responsible for overseeing the MMPA and ESA programs as applied to marine mammals, has come to the opposite conclusion. NMFS' conclusion is entitled to deference.

Your letter fails to address the appropriate legal standard, and makes incorrect and unsupported assumptions about the facts.

The ESA definition of harass is: "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include . . . breeding, feeding, or sheltering." 50 C.F.R. § 17.3. There is no possibility that the AET activities will even approach this standard.

In considering what constitutes harassment under the MMPA, the Ninth Circuit recently ruled that such harassment must entail a level of intrusiveness similar to killing, capturing or hunting. United States v. Hayashi, 22 F.3d 859 (9th Cir. 1994) (shooting toward but not hitting porpoises eating fish off of lines not harassment under the MMPA). The court found this interpretation analogous to the ESA regulatory definition, which also requires significant disruption of normal behavioral patterns.

The 120 dB sound field criterion applied in the EA is an extremely conservative measure of the applicable standards, particularly as applied to the location of the AET. 120 dB is the level found to result in a statistically measurable change in swim direction in a few mysticete species; by itself, a simple change in swim direction would not likely be found to constitute harassment under the MMPA or ESA. Moreover, the AET test area is not a migration, nursing, breeding, feeding, sheltering or similarly significant area from the standpoint of any of the animals that might be present.

Finally, proof of a taking also must be actual and concrete, and not based upon statistical speculation that a taking might occur, such as you suggest. National Wildlife Federation v. Burlington Northern Railroad, 23 F.3d 1508 (9th Cir. 1994)(the statistical chance that trains will strike and kill grizzly bears does not support an enforcement action asserting unpermitted taking during routine railroad operations). Your arguments fail to address this limitation.

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While your factual arguments are not entirely clear, you seem to urge that there will be sufficient populations of marine mammals in the vicinity of Jasper Seamount such that a "taking" by "harassment" would be unavoidable, and that the mitigation measures would fail to detect marine mammals in the area. Neither of these arguments is supported by any factual information, nor is either argument correct.

The only animals that could be affected by the AET are those with good low frequency hearing. There is no substantial evidence that sperm whales have good low frequency hearing, contrary to your suggestion. Sperm whales do not vocalize in low frequency registers comparable to the AET source -- one measure of potential low frequency hearing. Sperm whales also have hearing structures closely resembling other odontocetes; among the odontocetes for which audiograms are available, none have good low frequency hearing. No odontocete, including sperm whales, has shown a detectable change in behavior at these frequencies at even the 120 dB levels applied, conservatively, to all species in the EA. Instead, the 120 dB factor is derived from studies on certain mysticete whales and, as mentioned above, itself is quite conservative. However, densities of mysticete whales in the area are extremely low.

Scripps will not transmit AET sounds if any marine mammal is detected within 10/15 km from the site, depending upon the specific source site, either by visual or acoustic means.[3] In addition, if changes in acoustic behavior of animals coincident with AET sound transmissions are detected at any distance, operations will be suspended. Contrary to your suggestion, the fact that marine mammals may not vocalize all of the time will not significantly diminish the effectiveness of the acoustic monitoring system. Vocalizing marine mammals can be tracked over considerable distances, with a commonly cited example being a blue whale in the North Atlantic that was tracked over a period of 41 consecutive days. Animals will be visually tracked, or acoustically ranged, to avoid missing a quiet animal entering the exclusion zone.

The fact that Scripps will avoid transmitting when any marine mammals are detected in the area is conservative and not a requirement. Only marine mammals that could be "harassed" by these sounds need be avoided, and then only within the zone where harassment would occur. It is not coincidental that acoustic monitoring is very effective for the same animals (the mysticete whales) that commonly use low frequency sounds.

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[3]The 2 km reference at page vi of the draft EA is incorrect.

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You should note that, by extension, most vessel movements (which create 120 dB sound fields overlapping with potential marine mammal populations) would also be illegal under your interpretation of the MMPA and ESA. Similarly, under your interpretation, acoustic disturbance of other endangered species (such as a grizzly bear turning to observe a passing train, automobile or hiker), would also violate the law. There is no indication that Congress intended such a sensitive application of these statutes, bordering on the metaphysical, as confirmed by the Ninth Circuit's opinion in Burlington Northern cited above. Moreover, the Ninth Circuit's decision in Palila v. Hawaii Dept. of Land & Natural Resources, 852 F.2d 1106 (9th Cir. 1988) found "harm" under the ESA only where habitat degradation "could result in extinction." Id. at 1110-11. The Ninth Circuit specifically declined "to reach the issue of whether harm includes habitat degradation that merely retards recovery." Id. at 1110, cited in Burlington Northern, supra, 23 F.3d at 1513. Here, the AET has no chance of doing either. Moreover, as you know, even the Palila case represents just one side of a split between circuits, with other cases declining to find a taking as a result of habitat impacts.

Both Scripps and ARPA recognize that NMFS' October 21 letter is not an approval, and it remains Scripps' responsibility to avoid any unpermitted takings of marine mammals. NMFS' interpretation of the threshold of activities constituting a taking, however, will serve to guide Scripps' activities on the AET. The AET will also be monitored by one observer recommended by NMFS and one observer recommended by Cornell University.

I hope that this information is useful in addressing the concerns that you have expressed. In the future, please provide me with a copy of any correspondence to any University of California representatives (including Dr. Munk), and direct any legal communications regarding this matter to Mary Hudson (at the same address and number), to Steve Drown, University of California, Office of General Counsel, 300 Lakeside Drive, 7th Floor, Oakland, CA 94612 ((510) 987-9800), and to me.

Sincerely,

/S/

Alan Waltner

cc: Steve Drown
Mary Hudson
ARPA
NMFS

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA 92093

November 7, 1994

Mr. Raymond L. Chuan
Kauai Friends of the Environment
P.O. Box 1183
Hanalei, HI 96714

Dear Mr. Chuan:

This letter responds to your November 4, 1994 letter regarding the Baja acoustic engineering test (AET) and Kauai playback experiments. The AET is scheduled to begin this week, and the playback experiments will take place this winter, when sufficient numbers of humpback whales have returned to Hawaiian waters for the study to proceed.

We have attempted to keep interested parties informed of these activities. The AET was first announced to concerned environmentalists, including representatives of the Sierra Club Legal Defense Fund, at a meeting in San Francisco soon after it was proposed in July, 1994. The only response to that announcement, to our knowledge, was a letter from the Heller, Ehrman law firm in San Francisco to the National Marine Fisheries Service (NMFS) requesting review of whether a permit would be required under the Marine Mammal Protection Act (MMPA) or Endangered Species Act (ESA) for the AET. In the meantime, the Advanced Research Projects Agency (ARPA) began preparation of an Environmental Assessment (EA), and requested confirmation from NMFS in a September 8 letter of their conclusion that no "taking" of marine mammals would occur during the AET. On October 21, NMFS provided a response, conditioning its confirmation on several measures, including the termination of sound transmissions when an animal is detected within the zone of modified behavior (10-15 km, depending upon the site), rather than the 2 km zone that we previously had proposed. To our knowledge, no requests were received that ARPA or NMFS prepare an EA, or for an opportunity to comment on it.

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Since the AET will be undertaken in such a way that no "taking" of marine mammals will occur, no permits are required. Because of this, we recognized that there would be no formal processes to provide a basis for community input. For that reason, we circulated a project update on October 24, which you apparently have since received, to provide more detailed information on this activity. We provided the update promptly after receipt of NMFS' October 21 letter.

The playback experiments originally were suggested by the ATOC Marine Mammal Advisory Board, an independent group of scientists and other interested individuals. Drs. Tyack and Whitehead were among the concerned scientists that pressed for playback experiments. We did not anticipate a significant level of community concern given the fact that the playback experiments were essentially an environmentalist proposal. In addition, the playback experiments received extensive discussion among all of the members of the Advisory Board. The playback experiments are not scheduled to begin immediately, so there is ample time for any input that you would like to provide. You should realize, however, that the playback experiments are the initiative of the Advisory Board, and we would be very reluctant to make any changes to those experiments that are not agreed to by the Advisory Board. We therefore suggest that you forward any criticisms of the playback experiments both to us, and, through Dr. Tyack or other contacts, to the members of the Advisory Board.

As to your request for an opportunity to comment on the EA, while this is ARPA's principal responsibility, our counsel informs us that 30 days advance public notice of EAs is only required by the National Environmental Policy Act under certain limited circumstances, none of which apply here. This short term test of a sound source in the ocean, at sound intensities comparable to commercial ships, at a location where marine mammals are relatively sparse, and given the operational protocols described in the EA, is not one (or similar to one) that would normally require the preparation of an environmental impact statement, nor is the activity without precedent given these factors. If, however, you have substantive comments on the EA or the AET, we would appreciate receiving them promptly so that they may be considered.

Concerning your second point, we understand that the EA was in preparation by ARPA well before NMFS' October 21 letter, but that ARPA was awaiting the information contained in NMFS' letter before finalizing the EA. We are informed that the EA was signed on November 4.

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11-14-1994 08:48AM FROM ARPA/RPI IU 4101042 P.20
FROM ATOC PROJECT OFFICE-SIO 619/534-8076 11.08.1994 15:51 P. 4

On your third point -- the source termination distance for the AET -- our October 24 update is now obsolete and the 10/15 km buffer zones requested by NMFS will be complied with. The source operation also will be terminated when animals are acoustically/visually detected within the 10/15 km zones. We recognize that NMFS' October 21 letter is not an approval, and it remains our responsibility to avoid any unpermitted takings of marine mammals. NMFS' interpretation of the threshold of activities constituting a taking, however, will serve to guide our activities on the AET. The AET will also be monitored by observers selected by NMFS.

On your fourth point, we are re-reviewing the applicability of Permit No. 813 to these activities in response to your request. If it does not apply, we will not rely on it.

Concerning your final point, both the playback experiments and AET will help support various facets of the environmental review process including the California EIS. Those activities also have independent utility, since the AET will provide technical information about the ATOC concept in general and the playback experiments should generate useful information about marine mammal responses to low frequency noise. The AET will, among other things, evaluate the source levels and duty cycles necessary to support ATOC activities. The playback experiments proposed for Kauai are similar to previous studies elsewhere, and will help guide development of the Kauai MMRP. However, it is not expected that either of these activities will provide significant new information that would justify delayed issuance of the draft EISs; any such information will be addressed in the appropriate manner. In addition, it is likely that the AET results will be known before the Kauai draft EIS is completed, and possibly the California draft EIS as well.

I hope that this information is useful in addressing the concerns that you have expressed. I would also request that our efforts at keeping the public informed be judged in light of the number and diversity of individuals and organizations that have expressed an interest in our project.

Sincerely,

Walter

Walter Munk

cc: SCLDF
Rep. Patsy T. Mink
Dr. Ralph Alewine
Dr. William Fox

END

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Center for World Peace

HC 01, Box 420, Wailua, Moloka'i, Hawaii 96748 558-8923

Roy Schaefer
DLNR
PO Box 621
Honolulu 96809

DLNR OCEA

November 7, 1994

Dear Mr. Schaefer:

I am writing to ask that DLNR refuse to grant Conservation District Use Application #KA-2734, and to propose that the EIS for the ATOC Project should be global in scope, since it may ultimately threaten life -not just "marine" life, but possibly human life, as well- in all the world's oceans.

I am particularly concerned about the possible effect of the ATOC Project on Hawaii's humpback whales, which are supposed to be protected by law, as I indicated in my testimony to the National Marine Fisheries Service (a copy of which I have enclosed, and ask to be put on record).

It bothers me greatly that CDUA #KA-2734 does not include the required Management Plan for the Marine Mammal Research Project, which is the heart of the application, particularly since Scripps is honest enough to admit that "the proposed cable ... was prematurely laid in October 1993." Who let that happen? What has happened to them? And since Scripps admits that they jumped the gun, why have they not been found in violation of the law and fined?

Basically, I am asking that DLNR do its job and protect our environment. Please deny the Conservation District Use Application. Please enforce the law, and prosecute offenders who break the law. Please ask for a EIS that is global in scope, and that includes possible affects on humans.

Thank you very much for your time and attention.

Malama Pono!

[signature]

Claud Sutcliffe, PhD.

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA

August 29, 1994

Lieutenant Colonel Bruce Elliot
District Engineer
United States Army Corps of Engineers
Building 230 CEPOH-DB
Fort Shafter, Hawaii 96858-5440

Re: Acoustic Thermometry of Ocean Climate, Kauai Cable Installation; Application of Nationwide Permits

Dear Lieutenant Colonel Elliot:

This letter is submitted by the Scripps Institution of Oceanography, Institute for Geophysics and Planetary Physics, Acoustic Thermometry of Ocean Climate Project ("ATOC") to request authorization under 33 C.F.R. §§ 330.2(c) and 330.6(a) to apply one or more nationwide permits ("NWPs") for ATOC facilities proposed to be installed off the north shore of Kauai, Hawaii.

The ATOC project is an international research effort to determine long-term ocean climate changes on global scales by using acoustic sound paths in the sea's deep "sound channel" to precisely measure average ocean temperatures. Two sound sources are currently proposed. One will be located off the north shore of Kauai, as described below, and the other will be located offshore California near Point Sur, and will be the subject of a separate letter to the Corps of Engineers office in San Francisco.

Each sound source will be used to transmit low frequency, digitally coded sounds across the North Pacific ocean basin to receiving stations offshore Alaska. A receiving station is also proposed for Point Sur, California. By measuring the speed of these sounds, basin scale measurements of ocean temperatures can be obtained that will provide important information for studying global climate questions, particularly global warming due to the so-called greenhouse effect. The ATOC project is funded by the Advanced Research Projects Agency ("ARPA"), as part of the Strategic Environmental Research and Development Program ("SERDP").

The Kauai facilities will include a 260 watt output acoustic sound source to be located approximately 8 nm offshore, at 829 m depth, which is to be

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powered by a cable connected to a signal source and power amplifier in an existing building at the Barking Sands Pacific Missile Range Facility.

The ATOC project includes an extensive Marine Mammal Research Program ("MMRP") which will use a variety of observation platforms (aerial, ship based, shore based, and acoustic) to observe any possible responses by marine mammals and other sea animals to ATOC source sounds (although none are expected).

An associated project, funded by the Center for Excellence for Research in Ocean Sciences ("CEROS") will require an additional cable to be laid from an array of passive hydrophones in approximately 200 m water, north of Wainiha Bay, to shore. The purpose of this array is to track and record the vocalizations of marine mammals during the ATOC MMRP.[1]

We have concluded[2] that none of the ATOC installations outside of the three-mile band of territorial waters is subject to Corps of Engineers permitting requirements.[3] However, we have also concluded that at least some of the

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[1]The permit applicants for these facilities will be CEROS/State of Hawaii. However, since both ATOC and CEROS will be installing similar facilities, the analysis below appears to apply equally to ATOC and CEROS.

[2]The conclusions in this letter were discussed with Mike Lee of your staff on August 12.

[3]Clean Water Act Section 404, 33 U.S.C. § 1344, provides for the issuance of permits by the Corps of Engineers for "the discharge of dredged or fill material into the navigable waters . . ." 33 U.S.C. § 1362 (7) defines "navigable waters" to mean "the waters of the United States, including the territorial seas." The term "territorial seas" is defined in turn to include the area between the line of ordinary low water and the three mile limit. 33 U.S.C. § 1362(8). This definition is consistent with that contained in the Submerged Lands Act, 43 U.S.C. § 1301 (a), which defines "lands beneath navigable waters" to include those areas between the mean high tide line and the three mile limit. This is distinguished from the "Outer Continental Shelf" defined in 43 U.S.C. § 1331(a) to include "all submerged lands lying seaward and outside of the area of lands beneath navigable waters as defined in Section 1301 of this title and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control".

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proposed facilities within the three-mile band are subject to the Rivers and Harbors Act Section 10 program. We have been informed by Corps staff (in both the San Francisco and Honolulu offices) that cables and associated facilities are not considered "fill" for purposes of Section 404 of the Clean Water Act but the following discussion also addresses Section 404. We have also concluded that these facilities qualify for one or more nationwide permits, specifically NWPs 5, 6, and/or 12. We are requesting by this letter that you concur in this determination and authorize application of these NWPs. A more detailed description of the proposed facilities, the application of these NWPs, and related permitting activities, is set forth below.

Description of Facilities

The Kauai ATOC installation includes a subsea cable that is 27.8 miles long and 1.25 inches in diameter. The cable was laid in October 1993 by USNS MYER. This cable will connect the ATOC sound source (not yet installed) to an existing seashore cable interface 0.7 nm offshore from the Pacific Missile Range Facility, Barking Sands. The proposed ATOC source site is 22°21.003'N, 159°34.161'W, approximately 8 nm north of Hanalei Bay, in approximately 829 m of water.[4]

The cable route runs at about 100 m depth around the north and northwest side of Kauai, as shown in Figure 1. After traversing the northwest corner of Kauai, the route will run nearly straight down a fairly gentle sediment-covered slope to the proposed source site. The route has been established so as to run the cable along a flat path avoiding cable suspension and at sufficient depth not to be affected by surface waves. The route does not cross any submarine canyons and there is no evidence of any debris fields. Because the route is flat with a sediment cover, the cable will tend to bury itself.[5]

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[4]The ATOC source is an Alliant Techsystems ceramic, bender-bar acoustic source, roughly 7 feet high by 3 feet in diameter, in a 12 foot high galvanized steel tripod frame.

[5]The CEROS listening array will include 4 hydrophone pairs and 5 single hydrophones deployed in a "Y" orientation north of Wainiha Bay, Kauai, with a shore terminus to a house that fronts the Wainiha River outfall, as shown in Figure 2. The west arm of the array will be roughly 5 kilometers long and the east arm roughly 4 kilometers long, connected to shore via a 5 kilometer twisted pair cable that will be over-armored for the 2 km leading to shore.

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There is no anticipated impact on navigation by either the cable or the source, as they are both located on the seafloor. Fishing in Hawaii is comprised of shoreline and reef fishing in the shallow waters nearshore, and trolling, bottom-fishing and long line fishing in the offshore areas. There have been a few attempts at trawling, primarily for shrimp, but these have been discontinued due to the generally rough seafloor in the depth ranges of interest to the trawlers. To avoid the potential hazard to the cable from anchors used to hold fish aggregating devices deployed by the Aquatic Resource Division of the Hawaii Department of Land and Natural Resources, we will advise that agency of the cable and source location.

Application of Nationwide Permits

The three NWPs applicable to the ATOC cables are NWP 5 for scientific measurement devices (which applies to both Section 10 and Section 404)[6], NWP 6 for survey activities (which similarly applies to both Section 10 and 404)[7] and/or NWP 12 for cables (which only applies to Section 404).[8]

Here, it is our understanding that NWP 12, which applies to cables and associated structures, authorizes the entire project within the territorial seas for purposes of Section 404 but not Section 10. For Section 10 purposes, one or more of the other NWPs would authorize the source power cables within the three-mile band.

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[6] This category reads as follows: "5. Scientific Measurement Devices. Staff gages, tide gages, water recording devices, water quality testing and improvement devices and similar structures. . . ." No notice is required except for weirs and flumes between 10 and 25 cubic meters in size. 33 C.F.R. Pt. 330, App. A, B.5.

[7] 6. Survey Activities. Survey activities including core sampling, seismic exploratory operations, and plugging of seismic shot holes and other exploratory-type bore holes. . . ." No notice is required. 33 C.F.R. Pt. 330, App. A, B.6.

[8] 12. Utility Line Backfill and Bedding. Discharges of material for backfill or bedding for utility lines, including outfall and intake structures, provided there is no change in preconstruction contours. . . . The utility line itself will require a Section 10 permit if in navigable waters of the United States." No notice is required. 33 C.F.R. Pt. 330, App. A, B.12.

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NWP 5, for scientific measurement devices, is the most directly applicable. The sound source and associated power cable comprise one component of a larger scientific measurement device, with that sound source being used in a system to measure subsea acoustic travel times on a number of pathways in the North Pacific basin, which will be converted to temperature measurements of that basin for scientific purposes. It will also be used by the ATOC MMRP to study any possible responses of marine mammals and other sea animals to the source sounds (although none are expected). Therefore, NWP 5 authorizes the proposed cable for purposes of both Section 10 and Section 404.

Similarly, applying NWP 6, the source/power cable installations are part of a survey activity for the same acoustic travel time, temperature measuring and marine mammal research purposes described immediately above. It should be noted that the proposed sound source will emit sounds at much lower intensities than most of the activities listed in NWP 6.

As a result, we have concluded that one or more of the NWPs referenced above encompass installation of source power cable within the three-mile band, and request authorization to apply those NWPs to the ATOC Hawaii installation.

Other Regulatory Processes

Scripps has applied, or is in the process of applying, for a number of additional governmental approvals for the proposed project. Most of these approvals pertain to the broader Kauai ATOC installation and Marine Mammal Research Program, including the sound source installation and operation. Pertinent regulatory activities and their status include the following:

National Marine Fisheries Service. Scripps is the applicant for a scientific research permit under the Marine Mammal Protection Act and Endangered Species Act.

In addition, ARPA has requested consultation with the National Marine Fisheries Service ("NMFS") under the Endangered Species Act. This consultation is anticipated to be formally initiated in October with the filing of the combined federal/state Environmental Impact Statement for the project.

Environmental Impact Statement. NMFS, with the assistance of ARPA, and the Hawaii Department of Land and Natural Resources, serving as federal and state lead agencies respectively, are in the process of drafting a combined federal and state Environmental Impact Statement. The draft EIS is anticipated for public release in October.

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Hawaii Department of Land and Natural Resources. A Conservation District Use Permit Application has been submitted to the Hawaii Department of Land and Natural Resources.

Hawaii Coastal Zone Management Program. The Hawaii Coastal Zone Management Program office has indicated its intention to undertake consistency review under the Coastal Zone Management Act in connection with the NMFS scientific research permit application discussed above. We anticipate that this review will include all facets of the Kauai ATOC installation, including the installation of cable within the three mile limit.

In addition, by copy of this letter we are informing the Hawaii Department of Health of our determination that these NWPs apply to the proposed activity. Since the Corps has determined that cable projects are not subject to Section 404, it is our understanding that the water quality certification procedures of Section 401 do not apply. Given the nature of the proposed cables, potential water quality impacts are minimal to non-existent.

Conclusion

We appreciate your review under 33 C.F.R. §§ 330.2(c) and 330.6(a) of our conclusion that one or more nationwide permits apply to ATOC facilities proposed to be installed off the north shore of Kauai, Hawaii, and request authorization to apply those NWPs. If you have any questions or would like to discuss this matter further, please contact Russ Albertson, ATOC project office, (619) 534-7829, or our legal counsel, Alan Waltner, (510) 465-4494. Thank you for your assistance.

Sincerely,

Andrew Forbes

cc: National Marine Fisheries Service
Hawaiian Islands Humpback Whale National Marine Sanctuary
Environmental Protection Agency, Region IX
Hawaii Department of Land and Natural Resources
Hawaii Department of Health
Mike Lee, Corps of Engineers

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Kauai ATOC Cable Route

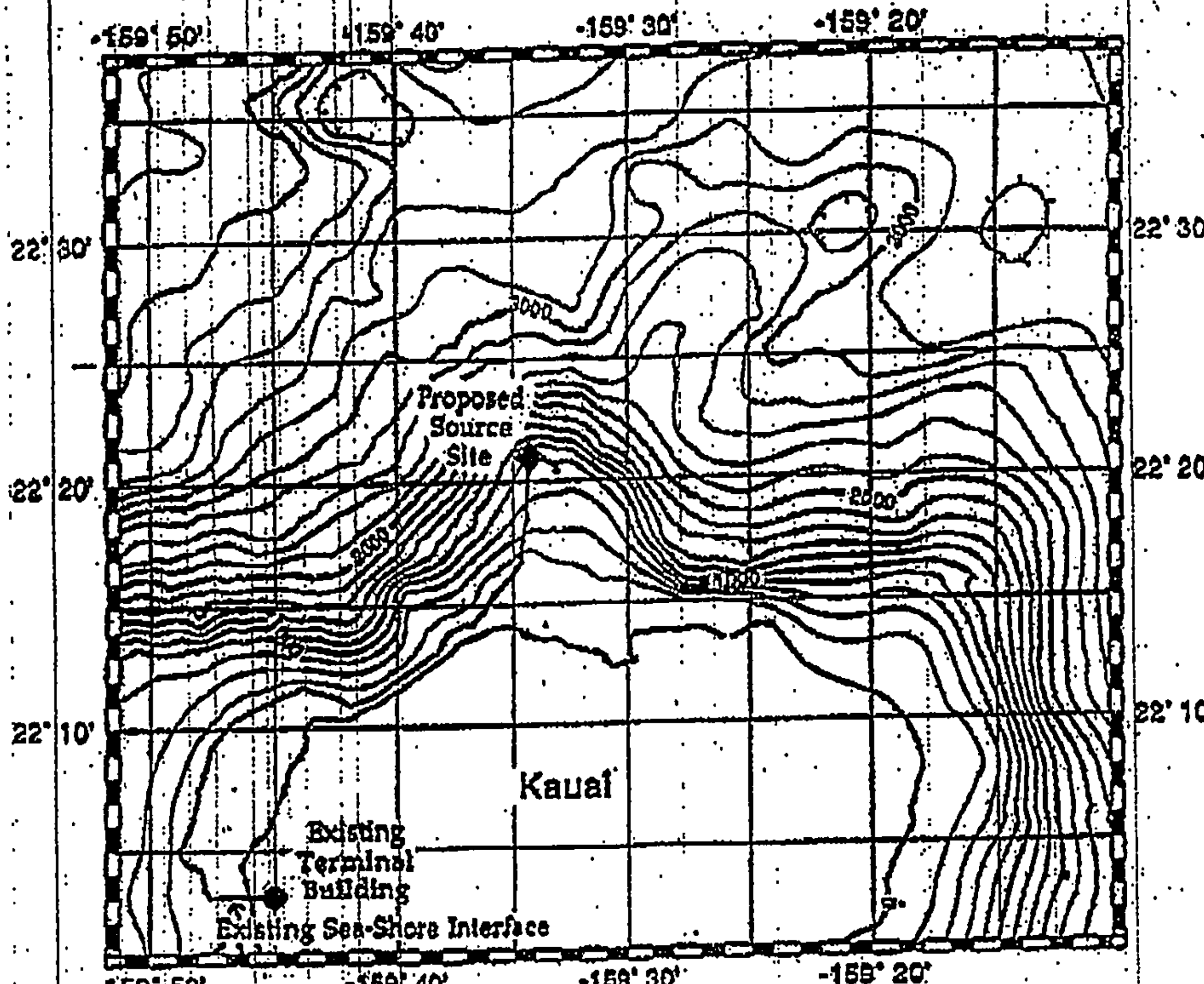

Figure 1 - Proposed Kauai Cable Route and Source Site

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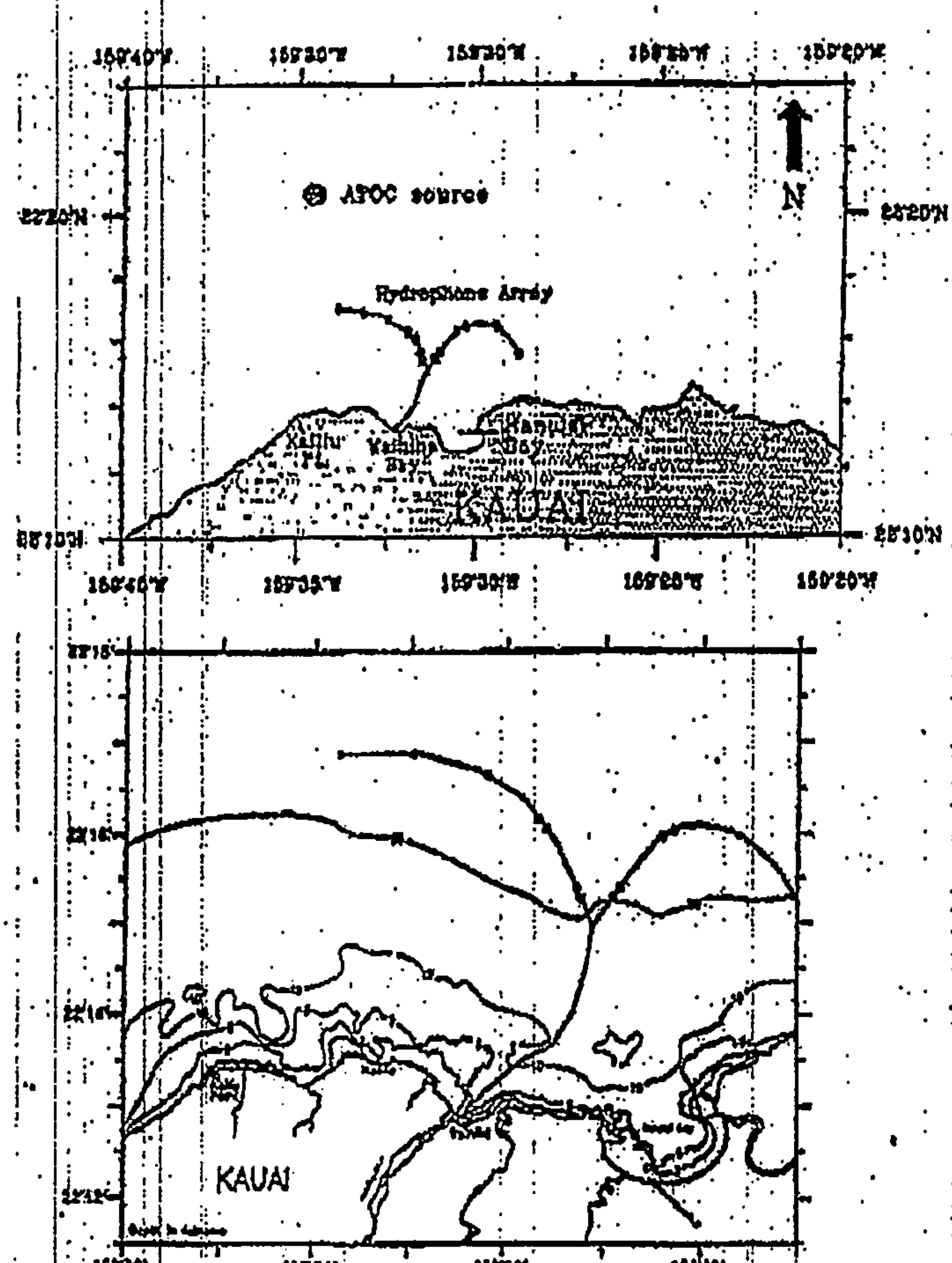

Figure 2. Proposed location and configuration of the hydrophone array and feeder cable north of Kauai, Hawaii.

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FILE OUT UCSD

UNIVERSITY OF CALIFORNIA, SAN DIEGO

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SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA, CALIFORNIA 92093

8 August, 1994

Roger Evans
Chief, Division of Conservation and Environmental Affairs
1151 Punchbowl
Department of Land and Natural Resources
Honolulu, HI 96809

Re: Acoustic Thermometry of Ocean Climate (ATOC)

Dear Mr. Evans,

With this letter the University of California, San Diego, Scripps Institution of Oceanography submits an application for a Conservation District Use Permit to install equipment on the ocean floor offshore of the Island of Kauai in order to carry out an acoustic thermometry of ocean climate ("ATOC") program and associated marine mammal research program. The Kauai installation would be part of an international research effort to prove the concept of measuring long-term climate changes using low frequency sound transmissions in the ocean's deep sound channel. The work is to be carried out by Scripps Institution of Oceanography in concert with Cornell University and other research institutions.

The project requires laying a cable along a 28-mile course on the north and northwestern side of Kauai. The cable will connect to a seashore cable interface 0.7 miles offshore, which was installed by the navy during the 1960's, and which connects via existing cable to the shore at the Pacific Missile Tracking Range, Barking Sands. (A map, TM 4-1-2-02, showing existing land use classifications is attached.) This existing cable rests on the ocean bottom and is not affected by the ATOC installation in that it is not put to any new, increased, or different use. The project also requires placement of a sound transmitter on the ocean floor approximately eight miles north of Hanalei Bay.

The enclosed application provides details concerning this equipment, methods of installation, and the purpose and operation information will be provided in the draft federal EIS. As we discussed at our July 20 meeting, the project sponsors support the concept of a joint federal-state EIS, and the National Marine Fisheries Service and the Advanced Research Projects Agency will coordinate with DLNR in preparing and circulating a joint document.

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An associated project, funded by the Center for Excellence for Research in Ocean Sciences (CEROS), will require an additional cable to be laid from an array of passive hydrophones in 70 m water depth, north of Hanalei Bay, to shore. The purpose of this array is to track and record the vocalizations of marine mammals during the ATOC Marine Mammal Research Program. A CDUA for this associated project will be submitted when agreement has been reached for development and use of the array between CEROS and ATOC.

Our application package includes the following:

1. 18 copies of the CDUA.
2. $50 filing fee
3. Tax Map 4-1-2-02
4. A copy of side scan sonar images of the proposed cable route
5. 18 copies of an environmental assessment
6. 4 copies of OEQC Bulletin Publication Form

We greatly appreciate your generosity in meeting with ATOC representatives several times in recent months and guiding us in understanding DLNR's permit review process. We look forward to working with your staff in connection with the ATOC project. In this process, I will serve as our primary point of contact with DLNR, and you and your staff should feel free to call me at any time. You should also feel free to contact the University of California's representative in Hawaii, John Craven, or Cornell University's representative, Michelle Wong-Wilson.

Sincerely,

Andrew Forbes
ATOC Deputy Director
Scripps Institution of Oceanography

cc: Betty Wood, Office of Environmental Quality Control
Ed Chen, Department of Health
Douglas Thom, Coastal Zone Management Program

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SAVE THE HUMANS

Center for World Peace, Waialua, Molokai 96748 Ph: 558-8923

Ann Terbush
Chief, Permits Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

April 14, 1994

Dear Dr. Tarbush:

I am writing to urge you, in the strongest possible terms, to deny scientific research permits Nos. P557 and P557A, on the grounds that they could conceivably threaten the extinction of the Humpback whales of Hawaii.

As the Hawaiian Islands Humpback Whale National Marine Sanctuary points out: "reduced to approximately 1,000 animals from the pre-whaling numbers of about 15,000, the North Pacific humpback populations have been estimated recently at between 1,500 to 3,000 animals. The humpback whale will not be considered by NOAA's National Marine Service (NMFS) recovered under the Endangered Species Act of 1973, as amended (ESA), until it reaches 60 percent of the prewhaling population (i.e., 9,000 animals)." (Discussion Paper for the Development of a Draft Environmental Impact Statement and Sanctuary Management Plan, Honolulu: U.S. Department of Commerce, National Oceanic and Atmospheric Administration and Office of the Governor, Office of State Planning, 1994, p. 15)

The humpbacks are an endangered species, who are protected by law reflecting the will of the people, and it is the job of the Office of Protected Resources -among other agencies- to protect them. Please do so.

It is also the job of the Hawaiian Islands Humpback Whale National Marine Sanctuary (whose Advisory Board I am asking to join). As they point out, "the Oceans Act of 1992 (The Act) simultaneously designated the Sanctuary and reauthorized and amended Title III of the MPRSA. According to the Act, the purposes of the Sanctuary are:

(1) to protect humpback whales and their habitat in the area described...
(2) to educate and interpret for lthe public the relationship of humpback whales to the Hawaiian Islands marine environment;
(3) to manage such human uses of the sanctuary consistent

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this subtitle and Title III of the MPRSA as amended by this Act... (Discussion Paper, p. 4)

The Humpbacks' habitat in the area described includes the waters off Kilauea National Wildlife Refuge on the island of Kauai, and the 1993 Aerial Survey they cite, done by Mobley, et. al., shows that many pods winter in those waters (Discussion Paper, Appendix B). Now, as I read p. 4b of ATOC's Marine Mammal Research Program's application, all of those protected waters off Kauai apparently will be within the projected Zone of Influence, i.e., area of admitted "Acoustic Harassment." So? As I read Table 1 of the application, Dr. Clark and his colleagues estimate that in the two years of the permit, they will "take" approximately 1,700 humpback whales (p. 5a). I commend their honesty, but I wish they had reminded the reader that this is the entire Hump-back population of the North Pacific!

So what, you say? Well, according to the ATOC application, "the most probable detectable effects on free-ranging marine mammals as a result of the scheduled ATOC transmissions off Kauai are disturbance-induced changes in: 1) distribution and relative abundance around the source, 2) behavioral and social activity patterns, and 3) sound production."

All of this is illegal and -I will argue- immoral, but what appears to most directly threaten the extinction of the humpbacks is the probable effect on sound production. As the Hawaiian Islands Humpback Whale National Marine Sanctuary points out: "Male humpbacks are the singers. Their long and complex sounds called songs are used to 'advertise' their virility and attract receptive females for breeding purposes." (Discussion Paper, p. 16)

Dr. Walter Munk of the ATOC team has publicly complained of poor and inaccurate reporting by the press, particularly the Los Angeles Times. So I took the opportunity in Honolulu on April 5th to ask his colleague Dr. David Hyde, the Project Director, if he was quoted correctly on p. A30 of the Los Angeles Times of March 26th, as follows: "We're not out to harm a single animal and we will stop the project if there is any evidence of that..." He said, "yes, that is correct." I then asked him what he meant by "harm" and "stop." I was not satisfied by his answer then, and I am even less satisfied after -finally- getting a chance to read the ATOC application.

Dr. Hyde never really said what he meant by "harm" and now I have read that the "probable detectable effects" include reduction in "sound production," with its implications for the future of the species. And he said what "stop" meant was "stopping the sound projection" of the ATOC underwater speaker. That is not enough.

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We should stop the sound projection of the ATOC underwater speaker before it starts, unless there are iron-clad guarantees (the kind that don't exist in the world of science) that not a single humpback will be harmed at all. As Dr. Clark and his colleagues admit on p. 23 of the ATOC application, "nothing is known about temporary shifts in hearing of marine mammals."

We, the people of Hawaii and the people of the United States, should use the Hawaiian Islands Humpback Whale National Marine Sanctuary and the Permits Division of the Office of Protected Resources to repay our moral debt to the species we decimated by protecting them.

That is what the law requires. More importantly, that is the right thing to do.

Kala mai. Forgive me, if I have offended you. But this mana'o I share is what my heart tells me.

Aloha! and Malama Pono!

Claud Sutcliffe, Ph.D.
Center for World Peace
Waialua, Molokai, Hawaii

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APPENDIX E

List of Agencies, Organizations and Individuals Consulted in Preparing the EIS

FEDERAL

U.S. Department of Interior, Fish and Wildlife Service

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Policy & Strategic Planning
William Archambault
Donna Wreting

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
William W. Fox, Director
Ann Terbush
Jeannie Drevenak
Gary Barone
Marty Freeman
Ken Hollingshead
Pamela Plotkin
Kevin Collins

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Scientific Research Department
Charlie Wahle
Helen Golde

U.S. Army Corps of Engineers, Honolulu District
Michael Lee, Chief Operations Dir.
Terrell Kelly

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, National Marine Mammal Laboratory
Doug DeMaster

Defense Nuclear Agency, Environmental Enforcement Office
Harry Stumpf

U.S. Department of the Navy, Space and Naval Warfare Systems Command
Dennis Colon

U.S. Department of Interior, Fish & Wildlife Service, Johnston Atoll
Chris Depkin
Roger Dirosa

Environmental Protection Agency, Region IX
Kathleen Johnson, Director

Marine Mammal Commission
John Twiss
Robert Hofman

STATE

Department of Business, Economic Development and Tourism
Ocean Resources Branch
Craig MacDonald

Department of Land and Natural Resources, State Historic Preservation Division
Don Hibbard

Department of Land and Natural Resources, Office of Conservation and Environmental Affairs
Roger Evans

Department of Land and Natural Resources, Division of Aquatic Resources
Paul Kawamoto

Department of Health, Clean Water Branch
Dennis L. Lau

Department of Land and Natural Resources, Division of Land Management
Sam Lee

Hawaii Department of the Attorney General
Lawrence K. Lau, Deputy Attorney General

Department of Health, Engineering Section
Edward Chen, Chief

Department of Transportation
Rex Johnson

Hawaii Office of Environmental Quality Control
Betty Wood

Pacific Missile Range Facility Barking Sands
P. McClaran

CITY AND COUNTY OF HONOLULU

U.S. Army Corp of Engineers
Mike Lee

Department of Transportation Services
Office of State Planning, Hawaii Coastal Zone Management, Honolulu Office
Douglas S.Y. Tom, Chief

Department of Commerce, National Marine Fisheries Service
Honolulu Office
John Naughton
Gene Nitta

ORGANIZATIONS

Center for Marine Conservation
Holly Price

Center for Monitoring Research
Tony Clark

Cornell University, Bioacoustic Research Program
David Mellinger
Russel Charif,
Connie Gordon

EBASCO Environmental, Inc.
Grotefendt
Rich
Mari Smultea

Environmental Defense Fund
Rod Fujita

Friends of the Sea Otter
Ellen Faurot-Daniels

Hawaii Audubon Society

Hawaii Institute of Marine Biology
Paul E. Nachtigall
Whitlow Au

Hawaiian Islands Humpback Whale National Marine Sanctuary
Janet Sessing

Center for World Peace
Claude Sutcliffe

Heller, Ehrman, White and McAuliffe

Hubbs Sea World Research Institute
Ann Bowles
Scott Eckert

Kauai Friends of the Environment
Beau Blair
Raymond Chuan

Kauai National Wildlife Refuge
Kathleen Viernes
Richard Voss

LGL, LTD., Ontario
JW. John Richardson

Loyola University, Psychology Department
Richard R. Fay

University of Florida, Communication Sciences Laboratory
Harry Hollien

Marine Acoustics, Inc., Newport, RI
William T. Ellison

Marine Acoustics Inc., Arlington, VA
Lee Shores

Moss Landing Marine Laboratories
James Duffy
Greg Calliet
Gary Green

Natural Resources Defense Council
Ann Nothoff
Joel Reynolds

Research Planning, Inc.
Al Cheaure

Save Our Shores, Santa Cruz, California
Vicki Nichols

Science Applications International Corporation, San Diego, CA
David W. Hyde

Science Applications International Corporation, McLean, VA
Peter Mikhalevsky
Ruth Keenan

International Fund for Animal Welfare
Jonathan Gordon

Sierra Club Legal Defense Fund, Hawaii
Paul Achitoff
Mark Smaalders
Denise Antolini
Annie Szvetecz

Sierra Club Legal Defense Fund, California
Michael Sherwood
Torry Estrada
Elizabeth Carpino

Earth Island Institute
Nicole Walthall

Texas A&M University, Marine Mammal Research Program
Bernd Wursig
David Weller

University of California, San Diego
Campus Planning Dept.
Marilyn Cox
Patricia Aguilar

University of Hawaii, Environmental Center
Jackie Miller

University of Hawaii, Dept. of Psychology
Alison Craig

University of Hawaii, Div. of Social Sciences
Joseph Mobley

University of Hawaii
Rick Grigg

University of Washington, Applied Physics Laboratory
Robert Spindell
Bruce Howe

University of Washington, Department of Statistics
Judy Zeh

Western Illinois University, Biology Department
Jeannette A. Thomas

Woods Hole Oceanographic Institution
Peter L. Tyack

INDIVIDUALS

Janet Doherty, Marine Mammal Biologist
Lexington, MA

Christine Gabriele, Marine Mammal Biologist
Gustavus, AK

Mia Grifalconi, Marine Mammal Biologist
Anchorage, AK

Mathew Irinaga, Marine Mammal Biologist
Anchorage, AK

Gene Kent, Marine Mammal Biologist
Santa Cruz, CA

Thomas Kieckhefer, Marine Mammal Biologist
Salinas, CA

Keoni McFadden
Kaneohe, HI

Thomas Norris, Marine Mammal Biologist
Moss Landing, CA

Katherine Payne, Marine Biologist
Ithaca, NY

Sylvia Earle, Marine Biologist
Oakland, CA

Linda S. Weilgart, Marine Mammal Biologist
Halifax, Nova Scotia, Canada

Hal Whitehead, Marine Mammal Biologist
Halifax, Nova Scotia, Canada