Final Determination and Rulemaking on the Harassment of Marine Mammals Incidental to Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar

EXECUTIVE SUMMARY

On August 12, 1999, the National Marine Fisheries Service (NMFS) received an application from the U.S. Navy, under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA), requesting an incidental, small take exemption for the taking of marine mammals by harassment incidental to deployment of the SURTASS LFA sonar for a period of time not to exceed 5 years. A description of the activity, the issues raised during public comment period, NMFS' responsibilities under the MMPA, the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA), and NMFS' findings and determinations on this action follows.

Under Section 101(a)(5)(A) of the MMPA, the Secretary shall allow, for periods of not more than 5 years, the incidental taking of small numbers of marine mammals within a specified geographical region if the Secretary finds that the total of such taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of the species or stock of marine mammal for subsistence uses. The Secretary is further required to prescribe regulations on the permissible methods of taking to result in the least practicable adverse impact on the species or stock and its habitat and to set forth requirements pertaining to monitoring and reporting such taking.

This determination and associated rulemaking does not authorize the operation of the SURTASS LFA sonar system since such authorization is under the jurisdiction of the U.S. Navy. Rather, NMFS is authorizing the unintentional incidental harassment of marine mammals in connection with this activity.

What is the SURTASS LFA system?

The SURTASS LFA sonar system is a long-range, low frequency (LF) sonar that has both active and passive components. The source level of each of the 18 individual projectors in the sonar array is approximately 215 dB. The sound field of the sonar array can never have a sound pressure level (SPL) higher than the SPL of an individual projector because of the physics involved in beam forming and transmission loss processes. By comparison, a SPL of 215 dB is significantly lower than the 255 dB SPL that can be produced by any of the 150 seismic survey vessels actively operating world-wide.

According to the U.S. Navy, the purpose of SURTASS LFA sonar is to provide a reliable and dependable system for improved detection and tracking of new-generation submarines at a longer range. This would maximize the opportunity for U.S. armed forces to safely react to, and defend against, potential submarine threats while remaining a safe distance beyond a submarine’s effective weapons range. No passive sonar systems are currently available that can accomplish this task.
The typical LFA sonar signal is not a constant tone, but rather a

transmission of various signal types that vary in frequency and duration (including continuous wave (CW) and frequency-modulated (FM) signals). Signal bandwidth is approximately 30 Hz. A complete sequence of sound transmissions is referred to as a pulse, or ping, and can last for as short as 6 seconds to as long as 100 seconds. The time between pings is typically from 6 to 15 minutes and the average duty cycle (ratio of sound "on" time to total time) can be controlled but, due to the design limit of the transducers, cannot be greater than 20 percent. The typical duty cycle is 10 to 15 percent.

SURTASS LFA sonar will operate a maximum of 2 ship systems in the world's ocean regions (it will not operate within 12 nautical miles (1 nm = 6,076 ft) of any coastline or operate in the polar seas). While the Navy originally proposed a maximum of 4 LFA sonar systems, and discussed the impacts of 4 systems in its Draft and Final Environmental Impact Statements (EIS), due to budget constraints only two systems will be available during the next five years (the time period for the MMPA regulations). Therefore, NMFS has assessed impacts for only 2 systems, not 4.

As explained later, while NMFS is authorizing the taking incidental to operating the SURTASS LFA sonar program for 5 years, the authorization will be reviewed annually and modifications and revisions may be made based on annual applications for Letters of Authorization (LOAs) from the Navy, research, monitoring, reporting, and the success of mitigation measures.

REGULATORY BACKGROUND

Because the SURTASS LFA sonar system has the potential to impact marine mammals and other marine resources, including marine mammals listed under the ESA, the U.S. Navy submitted an application for the taking of marine mammals under Section 101(a)(5)(A) of the MMPA, initiated consultation with NMFS and the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the ESA, conducted an environmental analysis under NEPA, and has completed consultation with all coastal States, except California, under the Coastal Zone Management Act, among other requirements.

National Environmental Policy Act

The U.S. Navy released a Draft EIS for public comment on July 23, 1999, and a Final EIS on February 2, 2001. The Navy held 5 public outreach meetings between August 19 and October 5, 1999 in Seattle, WA; Boston, MA; Miami, FL; Los Angeles, CA; and Honolulu, HI. In addition, the Navy held public hearings under NEPA on Sept. 29, 1999 in Norfolk VA, October 12th in San Diego, CA and October 14th in Honolulu, HI. NMFS participated in these meetings and hearings.

NMFS agreed to be a cooperating agency, as defined by the Council on Environmental Quality (CEQ), in the preparation of the Navy's Draft and Final EIS documents. As such, NMFS has adopted the Navy's Final EIS as its own as provided for by CEQ regulations, and accordingly, although not required by CEQ, has addressed public comments regarding

the Navy's Final EIS in the MMPA final rule.

Endangered Species Act

The U.S. Navy initiated consultation with NMFS on October 4, 1999, under section 7 of the ESA. That consultation was concluded on May 30, 2002. NMFS has determined that operation of the SURTASS LFA sonar system for testing, training and military operations and the issuance by NMFS of a small take authorization for this activity are not likely to jeopardize the continued existence of threatened or endangered species under the jurisdiction of NMFS or destroy or adversely modify critical habitats that has been designated for those species. Because of the offshore location of SURTASS LFA sonar, the Navy determined that it is unlikely that endangered or threatened species or designated critical habitat under the jurisdiction of the USFWS would be adversely affected.

Marine Mammal Protection Act

NMFS published a notice in the Federal Register on October 22, 1999 (64 FR 57026), requesting public comments on the U.S. Navy's application and proposed small take authorization. NMFS received a substantial number of comments from environmental organizations and the public in opposition to issuing this authorization. On March 19, 2001 (66 FR 15375), NMFS published a proposed rule to authorize the U.S. Navy to take small numbers of marine mammals incidental to operation of SURTASS LFA sonar and responded in that document to public concerns raised in response to the earlier notice. NMFS extended the proposed rule comment period from 45 days to 73 days in order to hold public hearings in Los Angeles, CA; Honolulu, HI; and Silver Spring, MD. During the public comment period, NMFS received over 10,000 letters in opposition to authorizing the Navy's request. Of these, 87 letters were chosen by NMFS for response in the final rule because they contained detailed questions and information warranting investigation and response for making a final decision.

Prior to the application under consideration and under Scientific Research Permits issued under Section 104 of the MMPA, the Navy funded independent scientists to conduct studies on the effect of LF sonar on blue, fin, humpback and gray whales. These species were selected because: (1) they are considered most likely among all marine mammals to have the best hearing in the SURTASS LFA sonar frequency band, (2) they have protected status under the ESA, and (3) there is prior evidence of some avoidance responses to LF sounds. The research determined that these LF-sensitive marine mammals exposed to SPLs ranging from 120 to 150 dB exhibited only minor, short-term, behavioral responses; there was no prolonged disruption of biologically important behavior. These findings contradicted previous predictions that marine mammals exposed to SPLs near 140 dB would exhibit disruption of behavior and avoid the area of higher noise levels. Research is underway on sperm and beaked whales.

Major Issues Raised by Public Comments

Deployment of SURTASS LFA sonar is considered controversial because of its potential for increased noise levels in the marine environment and alleged potential for hearing damage to, and mortality of, marine mammals and other sea life. Commenters believe that SURTASS LFA sonar does not qualify for a small take authorization because it is a global activity; that it will have more than a negligible impact on marine mammals; that insufficient research has been conducted on short-term and long-term impacts on marine mammals; that NMFS has not analyzed marine mammal takings during wartime; that the monitoring is insufficient; and because the modeling used for impact assessment is faulty. These issues are all addressed in significant detail in the final rule document and summarized in this document.

Mitigation of Potential Environmental Impacts

If NMFS makes a determination that an activity meets the requirements of the MMPA, it is responsible to prescribe methods of taking and other means of effecting the least practicable adverse impact on marine mammal species and their habitat. These measures are described here.

Coastal Restriction

This rule incorporates the Navy's commitment that the 180 dB re 1 μPa SPL isopleth would remain at least 12 nm from all coastlines, including islands. This measure ensures that coastal stocks of marine mammals and sea turtles will be relatively unaffected by LFA sonar due to high attenuation of sound in shoaling water. In addition, the Navy has established a safety zone for human divers at 145 dB around all known human commercial and recreational diving sites. Although this geographic restriction is intended to protect human divers, its implementation will also reduce the LF sound levels received by marine mammals, sea turtles and fish that are located in the vicinity of known dive sites.

Safety Zone

The best available science to date indicates that if marine mammals could be excluded from an area having an SPL of 180 dB or higher, they would not likely be injured. Therefore, NMFS is requiring a minimum 180-dB safety zone around the SURTASS LFA sonar. This means that if a marine mammal approaches the 180-dB safety zone and is detected, the SURTASS LFA sonar would not be operated. NMFS considers a 180-dB safety zone to be conservative, given that several of the large whale species vocalize at levels significantly higher than 180 dB. The acoustic properties of the LFA sound source are such that the 180-dB SPL will occur between 750-1,000 m (0.4-0.54 nm) from the LFA sound source. Under almost all oceanographic conditions the 180-dB SPL will not be beyond 1 km (0.54 nm) from the array.

The SURTASS LFA sonar's 180-dB safety zone can be visualized as having the shape of a hockey puck with a radius of 1 km (3,280 ft) and a width (depth) of 70 m (230 ft) suspended on a cable under the vessel with the top of the hockey puck at a nominal water depth of 87 m (285 ft). Because the sonar signals from all 18 projectors focus a

few hundred meters from the array and then beam-form at a nominal water depth between 87 to 157 m (285 to 515 ft), sonar signals outside the omni-directional "ray" path will rapidly decrease by 30 dB, or SPLs would be at least 1,000 times less intense (sound pressure measurements are logarithmic) outside the ray path. This means, for example, that marine mammals at or near the surface of the ocean, even if within 1 km (3,280 ft) of the LF sonar vessel, are unlikely to be exposed to high levels of sound. Even so, the SURTASS LFA sonar will not operate once a marine mammal is detected within 1 km (3,280 ft) of the sound source.

Detection

To ensure that marine mammals do not enter the 180-dB safety zone while the LFA system is in operation, they must be detected outside the safety zone so that the system can be shut down prior to an animal entering the safety zone. The U.S. Navy has proposed 3 methods to detect marine mammals outside the 1 km (3,280 ft) safety zone - visual, using crew members specifically trained to locate marine mammals at sea during all daylight hours; passive, using the SURTASS sonar's hydrophones to detect vocalizing marine mammals; and active (fish finding) sonar methods.

The active sonar method is a new system, based on standard, high-frequency (HF) fish-finder sonar technology, specifically redesigned by the U.S. Navy to locate marine mammals and sea turtles inside and outside the 180-dB safety zone. This system is called the HF marine mammal monitoring sonar or HF/M3. Tests, conducted by independent scientists under contract to the Navy, indicate that for each sonar signal or ping emitted by the HF/M3, the probability that marine mammals would be located within the 180-dB safety zone is above 95 percent. Since a marine mammal is likely to receive several pings between the limits of HF/M3 detection (2 km (1.1 nm)) and the 180-dB safety zone, detectability rises close to 100 percent prior to an animal entering the 180-dB SURTASS LFA mitigation zone. The results of these tests were presented at both the Marine Technology Society and the Acoustical Society of America annual meetings. A report on the tests and results is available at:

http://www.surtass-lfa-eis.com/Download/index.htm

Some commenters are concerned that the HF/M3 might also cause injury to marine mammals because of its loud signal. To avoid direct impacts from the HF/M3, NMFS is requiring Navy to ramp-up the HF/M3 sonar prior to use. This means that the signal strength of the HF/M3 will not be greater than the minimum output needed to detect a marine mammal or sea turtle. Once a marine mammal or sea turtle is located, ramping up will cease until the animal is no longer detected, and then ramped up to operating level to ensure that the safety zone is free of marine mammals and sea turtles. Commenters have confused the use of ramp-up for the HF/M3 from other situations where the sole purpose of ramp-up is to encourage marine mammals to leave an area due to an annoying signal.

Resonance

One hypothesis resulting from the stranding of several beaked whales in the Bahamas in March 2000, was that acoustic resonance would increase stress on living tissue to the point of injury to marine mammals at distances significantly greater than that projected for a 180-dB SPL. Resonance is a phenomenon whereby the amplitude of vibration is increased due to a match between the frequency of the signal and the properties of the material. A well-known example of resonance is the TV commercial with singer Ella Fitzgerald shattering a wine glass. Cudahy and Ellison (2002) found that *in vivo* (in the living body) and theoretical studies related to potential tissue damage from underwater sound support a damage threshold on the order of 180 to 190 dB. (A copy of Cudahy and Ellison (2002) is available at the above mentioned Web site.) In addition, wave lengths above 300 Hz could be a factor in causing resonance.

However, NMFS has determined, given the Cudahy and Ellison (2002) study, that the 180-dB safety zone should be augmented to ensure that marine mammals are not subject to potential injury from resonance. Until empirical research is completed (research is already underway funded by the Office of Naval Research (ONR)), NMFS has established a "buffer zone" extending an additional 1 km (0.54 nm) beyond the 180-dB safety zone. Therefore, as soon as a marine mammal (or sea turtle) is detected within the buffer zone (or safety zone), the SURTASS LFA sonar will either be turned off or not turned on.

Because wave length may be a factor in causing resonance, NMFS has additionally limited its authorization for the taking of marine mammals to frequencies no greater than 330 Hz instead of 500 Hz as proposed by the Navy; 330 Hz is the upper-bound of the lowest practicable operating frequency for the SURTASS LFA sonar. This mitigation measure is supported by the testimony of Dr. Darlene Ketten, an expert on the functional morphology of marine mammal hearing, before the Subcommittee on Fisheries Conservation, Wildlife and Oceans of the House Committee on Resources on October 11, 2001, that the consensus of data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 300 Hz or higher.

Habitat

Offshore Biologically Important Areas (OBIAs). To ensure that ocean habitats of biological significance to marine mammals are protected, NMFS has implemented a system to nominate OBIAs. OBIAs are exclusion zones for SURTASS LFA sonar operations only, that are located outside 12 nm (22 km) of any coastline, where SPLs from LFA sonar must not exceed 180 dB. However, it is very unlikely that the Navy will operate in the vicinity of any OBIA due to marine mammal abundance and because of the requirement to terminate transmissions whenever a marine mammal is detected by the HF/M3. This mitigation measure therefore ensures that these areas are provided more protection from this noise source than from other human noise sources. Current OBIAs include the waters of the East Coast of the United States and Canada

from Florida to Newfoundland out to the 200-m isobath to protect right whales, the subantarctic convergence zone during the austral summer, the Costa Rica dome in the Pacific Ocean, and Penguin Bank off the Island of Kauai, Hawaii, inside the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). The final rule has established a means for NMFS and the public to nominate additional OBIAs based on their biological importance to marine mammals.

National Marine Sanctuaries (NMSs) - The final rule prohibits taking marine mammals at a SPL greater than 180 dB within the offshore boundaries that extend beyond 12 nm (22 km) of the following NMSs to protect sanctuary resources: (1) Monterey Bay, (2) Gulf of the Farallones, (3) Cordell Bank and (4) the HIHWNMS (December-May); or 23 nm (37.4 km) during the months of December, January, March, and May of each year in the Olympic Coast NMS.

Determinations required by the MMPA

Section 101(a)(5) of the MMPA requires that to issue an authorization NMFS must determine that takings are (1) limited to a specific geographic region; (2) small in number, (3) negligible in impact, and (4) will not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses.

Specific Geographic Region - “Specified geographical region" means "an area within which a specified activity is conducted that has certain biogeographic characteristics" (50 CFR 216.104). For this purpose, in the proposed rule, the world's oceans were divided into 16 distinct geographic regions. After further deliberation, NMFS recognized that finer biogeographic scale was needed to address this criterion in order to meet the requirements of the MMPA and to ensure that the geographic region's characteristics will be distinct enough to contain specific marine mammal stock components. However, scientific information on marine mammal biogeography is insufficient to designate specific regions based solely on marine mammals. Therefore, NMFS has adopted (with modification) the biogeographic concept of Longhurst (1998), and has established a system of 15 biomes and 54 biogeographic provinces within those 15 biomes.

NMFS believes this meets the statutory mandate that the taking by the activity be within a "specified geographical region” since a biome is the most likely geographic region to contain the majority of a specific marine mammal stock. While the Longhurst (1998) schematic was designed for plankton, it is the best scientific application available for designating specified geographic regions because no biogeographic concept has been designed for marine mammals and, in general, the distribution of marine organisms at higher trophic levels resembles the general geographic patterns of primary productivity, with the largest aggregations concentrated in coastal areas and zones of upwelling. This means that the Navy will be required to notify NMFS annually as to which provinces it intends to operate SURTASS LFA sonar system during an upcoming year, and the extent of take (by harassment) it expects to occur. These calculations will be based on updated modeling by the Navy.

Small Numbers - The term "small numbers" is not defined in the MMPA. Congress noted "the imprecision of the term . . . but was unable to offer a more precise formulation because the concept is not capable of being expressed in absolute numerical limits" (H.Rept. 97-228, September 16, 1981). NMFS believes that by defining “small numbers” to mean a portion of a marine mammal species or stock whose taking would have a negligible impact on that species or stock (50 CFR 216.103), an upper limit is placed on the term, and the phrase effectively implements the Congressional intent underlying section 101(a)(5) of the MMPA. Commenters argue that Congress intended the “small numbers” determination to be separate from the negligible impact determination. However, the term "small numbers" becomes more difficult to apply equitably to affected Federal, state and local government agencies, maritime industries, and scientific researchers when takings are limited to incidental harassment. In all cases therefore, NMFS makes its determination based on whether the taking has the potential to impact the marine mammal stock and not solely on whether a number is quantitatively small. (For example, are 2,000 takings a "small number," but 2,001 takings are not a "small number," or are 2,000 takings by mortality a "small number," but 2,001 harassment takings are not a "small number" even if all takings are negligible?) Therefore, in the case of takings limited to potential incidental harassment, the determination of small has to be linked to the impact, negligible or otherwise, on the stock. This is the procedure NMFS has followed for similar actions since 1982.

Negligible Impact - "Negligible impact" is an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.104). The following factors support NMFS' determination that the takings by harassment as a result of the proposed activity would have a negligible impact on a species or stock: (1) the findings of the scientific research program on LF sounds on marine mammals indicated no significant change in biologically important behavior from exposure to sound levels up to 155 dB; (2) the small number of SURTASS LFA sonar systems that would be operating world-wide; (3) the relatively low duty cycle, short mission periods (noted previously) and offshore nature of the SURTASS LFA sonar (where there is lower marine mammal abundance); (4) for convergence zone (CZ) propagation, the characteristics of the acoustic sound path, which deflect the sound below the water depth inhabited by marine mammals for approximately 75 percent of the distance between the source and the first CZ and between the first CZ and the second CZ (approximately 45 km), when the SURTASS LFA sonar vessel is operating in water with this characteristic; (5) for CZ propagation, the narrow width of the ray path and the 1,000-fold decrease in the intensity of the sound immediately outside the ray path, further limiting exposure; (6) that the vessel must be underway while transmitting (in order to keep the receiver array deployed), limiting the duration of exposure for marine mammals to those few minutes when the LFA sound is moving through that part of the water column inhabited by marine mammals; and (7) implementation of the previously mentioned mitigation measures that make it unlikely for a marine mammal to be within the

180-dB sound field during sonar transmissions without being detected. These measures all indicate that while marine mammals will potentially be affected by the SURTASS LFA sonar sounds, these impacts will be short-term and will not affect the survival or reproductive potential for marine mammals on a species or stock basis.

Moreover, NMFS has determined that the estimates of taking by harassment incidental to SURTASS LFA sonar provided in the Navy's Final EIS are significantly higher than the more realistic 1 to 2 percent (or less) of affected stocks during a single 30-day mission. Therefore to ensure, to the greatest extent practicable, that the taking determinations for this action remain negligible in the future on a stock-by-stock basis, NMFS has determined that short-term incidental harassment levels between 1 and 12 percent (2 percent X six 30-day missions = 12 percent) and below comply with the MMPA as Level B harassment at this level is unlikely to result in significant effects on any species' or stock's reproduction or survival. Therefore, takings by SURTASS LFA sonar operations during the effective time period (1 year) of any LOA issued for such Navy operations must not exceed 12 percent of any marine mammal stock. However, this 12 percent level should not be interpreted to mean that the Navy will take up to 12 percent of all affected marine mammal stocks. In most cases, with carefully planned SURTASS LFA sonar missions (e.g., to avoid certain biogeographic provinces during seasons of increased marine mammal abundance), the total annual Level B takes are expected to be significantly less than this level. NMFS encourages the Navy to plan missions in areas and at times and seasons where the smallest number of marine mammals would be taken; and if necessary, will reject an annual small take authorization for areas in seasons that have a potential for significantly increased levels of harassment.

Impact on the availability for subsistence uses - SURTASS LFA sonar will not operate in Arctic waters so it will not impact subsistence hunting in the Bering, Chukchi or Beaufort seas.

Monitoring and Reporting Requirements - The MMPA requires that regulations set forth requirements pertaining to the monitoring and reporting of the taking by the activity. For SURTASS LFA sonar, these requirements include the tripartite monitoring system (mentioned previously), the conditions for conducting that monitoring, and research to support or refute NMFS' finding of negligible impact. In addition, the Navy is required to submit a report (classified) on its monitoring program quarterly on all missions that have been completed within 30 days of the due date of the report. An annual, unclassified comprehensive report analyzing the impacts on marine mammals from all missions is also required.

Least practicable adverse impact - Section 101(a)(5)(A)(ii) of the MMPA requires NMFS to "prescribe regulations setting forth permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impacts on species or stocks and its habitat..." NMFS has determined that this

requirement has been met by the Navy through incorporation of the tripartite monitoring program and shutdown criteria; the requirement to remain at least 12 nm offshore of all coastlines, including islands; the establishment of OBIAs to protect marine mammals; the implementation of interim operating restrictions (buffer zone and 330 Hz limitation) and the requirement to plan missions to the greatest extent practical to avoid areas and seasons of marine mammal abundance.

Research

While NMFS believes that research conducted to date is sufficient to assess impacts on those species of marine mammals it believes that the Navy should continue research. Accordingly, NMFS is recommending that the Navy conduct research on (among other things): (1) the behavioral reactions of whales to sound levels that were not tested during the research phase, specifically between 155 dB and 180 dB, (2) the responses of sperm and beaked whales to LF sonar signals, (3) the habitat preferences of beaked whales, (4) passive acoustic monitoring for the possible silencing of calls of large whales using bottom- mounted hydrophones, and (5) long term, cumulative effects on a stock of marine mammal that is expected to be regularly exposed to LFA and monitor it for population changes throughout the five-year period.

Other Issues

A final issue is that the Navy’s application has not requested a taking of marine mammals during periods of "Heightened Threat Condition (HTC)," a condition determined by Congress or the National Command Authorities (the President and the Secretary of Defense as assisted by the Chairman of the Joint Chiefs of Staff). In the unlikely event that a HTC was declared and the Navy's SURTASS LFA sonar assets were included in this condition, the LOA would be placed in abeyance until the HTC ended. This is appropriate since the Navy did not request takings during an HTC. Upon termination of the HTC, NMFS would then reassess the impact on marine mammals using information from the activity area(s) and updated modeling results to determine whether the potential takings in the future would continue to have no more than a negligible impact on affected marine mammal stocks. For example, additional mitigation might be required to ensure that the stocks affected during the HTC were not additionally impacted during the period of the regulations' effectiveness.

Conclusions

Based on the scientific analyses detailed in the Navy application and further supported by information and data contained in the Navy’s Final EIS for SURTASS LFA sonar operations, NMFS concurs with the Navy that the incidental taking of marine mammals resulting from SURTASS LFA sonar operations would be limited to small numbers (as the term is defined in 50 CFR 216.103) of marine mammals, have no more than a negligible impact on the affected marine mammal stocks or habitats and not have an unmitigable adverse impact on Arctic

subsistence uses of marine mammals. These conclusions are further supported by the required mitigation measures that would be implemented for all SURTASS LFA sonar operations and the required monitoring program. This includes geographic operation restrictions, mitigation measures to minimize injury to any marine mammals, monitoring and reporting takings and supplemental research that will result in increased knowledge of marine mammal species and the potential impacts of LF sound on these species. In addition to ONR funding this research (plans for FY02 call for an increase to approximately $7M, contingent on final budget approval), the Navy intends to spend $1 million annually to fund the latter measures, which will offer the means of learning, encouraging, and coordinating research opportunities, plans, and activities relating to reducing the incidental taking of marine mammals from anthropogenic underwater sound, and evaluating the possible long-term effects from exposing marine mammals to anthropogenic sound.

References: Cudahy, E. and W.T Ellison. 2001. A review of the potential for in vivo tissue damage by exposure to underwater sound. Naval Submarine Medical Research Laboratory. New London, CT.

Longhurst, Alan R. 1998. Ecological Geography of the Sea. Academic Press, San Diego, CA. 398 pp.