DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 218

RIN 0648–AX11

Taking and Importing Marine Mammals; U.S. Navy's Research, Development, Test, and Evaluation Activities Within the Naval Sea Systems Command Naval Undersea Warfare Center Keyport Range Complex

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Proposed rule; request for comments.

SUMMARY: NMFS has received a request from the U.S. Navy (Navy) for authorization to take marine mammals incidental to the Navy's Research, Development, Test, and Evaluation (RDT&E) activities within the Naval Sea System Command (NAVSEA) Naval Undersea Warfare Center (NUWC) Keyport Range Complex and the associated proposed extensions for the period of September 2009 through September 2014. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is proposing regulations to govern that take and requesting information, suggestions, and comments on these proposed regulations.

DATES: Comments and information must be received no later than August 6, 2009.

ADDRESSES: You may submit comments, identified by 0648–AX11, by any one of the following methods:

- *Electronic Submissions:* Submit all electronic public comments via the Federal eRulemaking Portal *http://www.regulations.gov*
- *Hand delivery or mailing of paper, disk, or CD–ROM:* Comments should be addressed to Michael Payne, Chief, Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910–3225.

Instructions: All comments received are a part of the public record and will generally be posted to *http://www.regulations.gov* without change. All personal identifying information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

NMFS will accept anonymous comments (enter N/A in the required fields if you wish to remain anonymous). Attachments to electronic comments will be accepted in Microsoft Word, Excel, WordPerfect, or Adobe PDF file formats only.

FOR FURTHER INFORMATION CONTACT: Shane Guan, Office of Protected Resources, NMFS, (301) 713–2289, ext. 137.

SUPPLEMENTARY INFORMATION:

Availability

A copy of the Navy's application may be obtained by writing to the address specified above (see **ADDRESSES**), telephoning the contact listed above (*see* **FOR FURTHER INFORMATION CONTACT**), or visiting the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm.* The Navy's Draft Environmental Impact Statement (DEIS) for the Keyport Range Complex RDT&E and range extension activities was published on September 12, 2008, and may be viewed at *http://www-keyport.kpt.nuwc.navy.mil.* NMFS participated in the development of the Navy's DEIS as a cooperating agency under the National Environmental Policy Act (NEPA).

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) during periods of not more than five consecutive years each if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such taking are set forth. NMFS has defined ''negligible impact'' in 50 CFR 216.103 as:

> 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.

The National Defense Authorization Act of 2004 (NDAA) (Public Law 108–136) removed the ''small numbers'' and ''specified geographical region'' limitations in sections 101(a)(5)(A) and (D) and amended the definition of ''harassment'' as it applies to a ''military readiness activity'' to read as follows (Section 3(18)(B) of the MMPA):

> (i) Any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].

Summary of Request

On May 15, 2008, NMFS received an application from the Navy requesting authorization for the take of 5 species of marine mammals incidental to the RDT&E activities within the NAVSEA NUWC Keyport Range Complex Extension over the course of 5 years. These RDT&E activities are classified as military readiness activities. On April 29, 2009, NMFS received additional information and clarification on the Navy's proposed NAVSEA NUWC Keyport Range Complex Extension RDT&E activities. The Navy states that these RDT&E activities may cause various impacts to marine mammal species in the proposed action area. The Navy requests an authorization to take individuals of these marine mammals by Level B Harassment. Please refer to Tables 6–23, 6–24, 6–25, and 6–26 of the Navy's Letter of Authorization (LOA) application for detailed information of the potential marine mammal exposures from the RDT&E activities in the Keyport Range Complex Extension per year. However, due to the proposed mitigation and monitoring measures and standard range operating procedures in place, NMFS estimates that the take of marine mammals is likely to be lower than the amount requested. NMFS does not expect any marine mammals to be killed or injured as a result of the Navy's proposed activities, and NMFS is not proposing to authorize any injury or mortality incidental to the Navy's proposed RDT&E activities within the Keyport Range Complex Extension.

Background of Navy Request

The Navy proposes to extend the NAVSEA NUWC Keyport Range Complex in Washington State. The NAVSEA NUWC Keyport Range Complex has the infrastructure to support RDT&E activities. Centrally located within Washington State, the

NAVSEA NUWC Keyport Range Complex has extensive existing range assets and capabilities. The NAVSEA NUWC Keyport Range Complex is composed of Keyport Range Site, Dabob Bay Range Complex (DBRC) Site, and Quinault Underwater Tracking Range (QUTR) Site (*see* Figure 1–1 of the Navy's LOA application).

The goal of the Proposed Action is to extend the operational areas of each range site. Extending the Range Complex operating areas outside existing range boundaries will allow the Navy to support existing and future range activities including evolving manned and unmanned vehicle program needs in multiple marine environments. With the proposed extension of the Keyport and QUTR range sites, the range sites could support more activities, which include increases in the numbers of tests and days of testing. No additional operational tempo is proposed for the DBRC Site. Existing and evolving range activities applied for in this LOA application include RDT&E and training of system capabilities such as guidance, control, and sensor accuracy of manned and unmanned vehicles in multiple marine environments (*e.g.,* differing depths, salinity levels, temperatures, sea states, etc.).

The range extension is necessary to provide adequate testing area and volume (*i.e.,* surface area and water depth) in multiple marine environments. The extension enables the NUWC Keyport to fulfill its mission of providing test and evaluation services in both surrogate and simulated war-fighting environments for emerging manned and unmanned vehicle program activities. Within the NAVSEA NUWC Keyport Range Complex Extension, the NUWC Keyport activities include testing, training, and evaluation of systems capabilities such as guidance, control, and sensor accuracy of manned and unmanned vehicles in multiple marine environments (*e.g.,* differing depths, salinity levels, temperatures, sea states, etc.).

NUWC Keyport consists of 340 acres (138 hectares [ha]) on the shores of Liberty Bay and Port Orchard Reach (a.k.a. Port Orchard Narrows), and is located adjacent to the town of Keyport, due west of Seattle. NUWC Keyport, a part of NAVSEA, is the center for integrated undersea warfare systems dependability, integrated mine and undersea warfare supportability, and undersea vehicle maintenance and engineering. It provides test and evaluation, in-service engineering, maintenance, Fleet readiness, and industrial-based support for undersea warfare systems, including RDT&E of torpedoes, unmanned vehicles, sensors, targets, countermeasure systems, and acoustic systems.

The NAVSEA NUWC Keyport Range Complex is divided into open ocean/offshore areas and in shore areas:

- *Open Ocean Area*—air, surface, and subsurface areas of the NAVSEA NUWC Keyport Range Complex that lie outside of 12 nautical miles (nm) from land.
- *Offshore Area*—air, surface, and subsurface ocean areas within 12 nm of the Pacific Coast.
- *Inshore*—air, surface, and subsurface areas within the Puget Sound, Port Orchard Reach, Hood Canal, and Dabob Bay.

Keyport Range Site

Located adjacent to NUWC Keyport, this range provides approximately 1.5 square nautical miles (nm^2) (5.1 square kilometers [km^2]) of shallow underwater testing, including in-shore shallow water sites and a shallow lagoon to support integrated undersea warfare systems and vehicle maintenance and engineering activities (see Figures 1–2 and 1–3 of the Navy's LOA application). The Navy has conducted underwater testing at the Keyport Range Site since 1914. Underwater tracking of test activities is accomplished by using temporary or portable range equipment. The range is currently used an average of 6 times per year for vehicle testing and a variety of boat and diver training activities, each lasting 1–30 days. There may be several activities in 1 day. The range site also supports: (1) Detection, classification, and localization of test objectives and (2) magnetics measurement programs. Explosive warheads are not placed on test units or tested within the Keyport Range Site.

DBRC Site

Currently, the DBRC Site assets include the Dabob Bay Military Operating Area (MOA), the Hood Canal North and South MOAs adjacent to Submarine Base (SUBASE) Bangor, and the Connecting Waters (*see* Figures 1–2 and 1–4 of the Navy's LOA application). The DBRC Site is the Navy's premier location within the U.S. for RDT&E of underwater systems such as torpedoes, countermeasures, targets, and ship systems. Primary activities at the DBRC Site support proofing of underwater systems, research and development test support, and Fleet training and tactical evaluations involving aircraft, submarines, and surface ships. Tests and evaluations of underwater systems, from the first prototype and pre-production stages up through Fleet activities (inception to deployment), ensure reliability and availability of underwater systems and their Fleet components. As with the Keyport Range Site, there are no explosive warheads tested or placed on test units.

The DBRC Site also supports acoustic/magnetic measurement programs. These programs include underwater vehicle/ship noise/magnetic signature recording, radiated sound investigations, and other acoustic evaluations. In the course of these activities, various combinations of aircraft, submarines, and surface ships are used as launch platforms. Test equipment may also be launched or deployed from shore off a pier or placed in the water by hand. NUWC Keyport currently conducts activities within four underwater testing areas in the DBRC Site. These areas are:

- *Dabob Bay MOA*—a deep-water range in Jefferson County approximately 14.5 nm^2 (49.9 km^2) in size. The acoustic tracking space within the range is approximately 7.3 by 1.3 nm (13.5 by 2.4 km) (9.5 nm^2 [32.4 km^2]) with a maximum depth of 600 ft (183 m). The Dabob Bay MOA is the principal range and the only component of the DBRC Site with extensive acoustic monitoring instrumentation installed on the seafloor, allowing for object tracking, communications, passive sensing, and target simulation.
- *Hood Canal MOAs*—There are two deep-water operating areas adjacent to SUBASE Bangor in Hood Canal: Hood Canal MOA South, which is approximately 4.5 nm^2 (15.4 km^2) in size, and Hood Canal MOA North, which is approximately 7.9 nm^2 (27.0 km^2) in size. Both areas have an average depth of 200 ft (61 m). The Hood Canal MOAs are used for vessel sensor accuracy tests and launch and recovery of test systems where tracking is optional.
- *Connecting Waters*—the portion of the Hood Canal that connects the Dabob Bay MOA with the Hood Canal MOAs. The shortest distance between the Dabob Bay MOA and Hood Canal MOA South by water is approximately 5.8 nm^2 (19.8 km^2). Water depth in the Connecting Waters is typically greater than 300 ft (91 m).

QUTR Site

The Navy has conducted underwater testing at the QUTR Site since 1981 and maintains a control center at the Kalaloch Ranger Station. As at the other range sites, no explosive warheads are used at the QUTR Site. The QUTR Site is a rectangular-shaped test area of about 48.3 nm^2 (165.5 km^2), located approximately 6.5 nm (12 km) off the Pacific Coast at Kalaloch, Washington. It lies within the boundaries of the Olympic Coast National Marine Sanctuary (OCNMS).

The QUTR Site is instrumented to track surface vessels, submarines, and various undersea vehicles. Bottom sensors are permanently mounted on the sea floor for tracking and are maintained and configured by the Navy. The sensors are connected to the shore via cables, which extend under the beach to the bluffs and end at a Navy trailer in Kalaloch (National Park Service [NPS] property). In addition, portable range equipment may be set up prior to conducting various activities on the range and removed after it is no longer needed. All communications are sent back to NUWC Keyport for monitoring.

This range underlies a small portion (W–237A) of the larger airspace unit W–237. This airspace complex comprises the northern portion of the Pacific Northwest Ocean Surface/Subsurface Operating Area (OPAREA), NOAA chart number 18500 (NOAA, 2006). Activities in this airspace are scheduled and coordinated with Naval Air Station (NAS) Whidbey Island and Commander Submarine Force, U.S. Pacific Fleet (COMSUBPAC).

All range areas in the NAVSEA NUWC Keyport Range Complex Extension include areas where marine mammals may be found. Range activities will be conducted in the Keyport Site, the DBRC, and the QUTR Site. The proposed annual usage at each site is listed in Table 1. This includes tracking sonar systems, side-scan, and thermal propulsion systems.

TABLE 1—PROJECTED ANNUAL DAYS OF USE BY RANGE SITE

	Keyport range site	DBRC site	QUTR site—offshore	QUTR site—surf zone
Current	55	200	14	0
Proposed	60	200	16	30

Description of the Specified Activities

Typical activities conducted in the NAVSEA NUWC Keyport Range Complex Extension on the three existing range sites primarily support undersea warfare RDT&E program requirements, but they also support general equipment test and military personnel training needs, including Fleet activities. These activities involve mid- and high-frequency acoustic sources with the potential to affect marine mammals that may be present within the NAVSEA NUWC Keyport Range Complex Extension. Current and proposed activities within the Keyport Range Complex Extension are listed below:

Range Activities: Testing That Involves Active Acoustic Devices

A list of the primary active acoustic sources used within the NAVSEA NUWC Keyport Range Complex with information on the frequency bands is shown in Table 2. In this document, low frequency is defined as below 1 kiloHertz (kHz), mid frequency is defined as between 1 kHz and 10 kHz, and high frequency is defined as above 10 kHz.

TABLE 2—PRIMARY ACOUSTIC SOURCES COMMONLY USED WITHIN THE NAVSEA NUWC KEYPORT RANGE COMPLEX

Source	Frequency (kHz)	Maximum source level (dB re 1 μPa-m)
Sonar:		
General range tracking (at Keyport Range Site)	10–100	195
General range tracking (at DBRC and QUTR Sites)	10–100	203
UUV tracking	10–100	195
Torpedoes	10–100	233
Range targets and special tests (at Keyport Range Site)	5–100	195
Range targets and special tests (at DBRC and QUTR Sites)	5–100	238
Special sonars (*e.g.,* UUV payload)	100–2,500	235
Fleet aircraft—active sonobuoys and helo-dipping sonars	2–20	225
Side-scan	100–700	235
Other Acoustic Sources:		
Acoustic modems	10–300	210
Target simulator	0.1–10	170
Aid to navigation (range equipment)	70–80	210
Sub-bottom profiler	2–7	210
	35–45	220
Engine noise (surface vessels, submarines, torpedoes, UUVs)	0.05–10	170

(1) General Range Tracking

General range tracking on the instrumented ranges and portable range sites have active output in relatively wide frequency bands. Operating frequencies are 10 to 100 kHz. At the Keyport Range Site the sound pressure level (SPL) of the source (source level) is a maximum of 195 dB re 1 μPa-m. At the DBRC and QUTR sites, the source level for general range tracking is a maximum of 203 dB re 1 μPa-m.

(2) UUV Tracking Systems

UUV tracking systems operate at frequencies of 10 to 100 kHz with maximum source levels of 195 dB re 1 μPa-m at all range sites.

(3) Torpedo Sonars

Torpedo sonars are used for several purposes including detection, classification, and location and vary in frequency from 10 to 100 kHz. The maximum source level of a torpedo sonar is 233 dB re 1 μPa-m.

(4) Range Targets and Special Tests

Range targets and special test systems are within the 5 to 100 kHz frequency range at the Keyport Range Site with a maximum source level of 195 dB re 1 μPa-m. At the DBRC and QUTR sites, the maximum source level is 238 dB re 1 μPa-m.

(5) Special Sonars

Special sonars can be carried as a payload on a UUV, suspended from a range craft, or set on or above the sea floor. These can vary widely from 100 kHz to a very high frequency of 2,500 kHz for very short range detection and classification. The maximum source level of these acoustic sources is 235 dB re 1 μPa-m.

(6) Sonobuoys and Helicopter Dipping Sonar

Sonobuoys and helicopter dipping sonars are deployed from Fleet aircraft and operate at frequencies of 2 to 20 kHz with maximum source levels of 225 dB re 1 μPa-m. Dipping sonars are active or passive devices that are lowered on cable by helicopters or surface vessels to detect or maintain contact with underwater targets.

(7) Side Scan Sonar

Side-scan sonar is used for mapping, detection, classification, and localization of items on the sea floor such as cabling, shipwrecks, and mine shapes. It is high frequency typically 100 to 700 kHz using multiple frequencies at one time with a very directional focus. The maximum source level is 235 dB re 1 μPa-m. Side-scan and multibeam sonar systems are towed or mounted on a test vehicle or ship.

(8) Other Acoustic Sources

Other acoustic sources may include acoustic modems, targets, aids to navigation, subbottom profilers, and engine noise.

- An acoustic modem is a communication device that transmits an acoustically encoded signal from a source to a receiver. Acoustic modems emit pulses from 10 to 300 kHz at source levels less than 210 dB re 1 μPa-m.
- Target simulators operate at frequencies of 100 Hertz (Hz) (0.1 kHz) to 10 kHz at source levels of less than 170 dB re 1 μPa-m.
- Aids to navigation transmit location data from ship to shore and back to ship so the crew can have real-time detailed location information. This is typical of the range equipment used in support of testing. New aids to navigation can also be deployed and tested using 70 to 80 kHz at source levels less than 210 dB re 1 μPa-m.
- Subbottom profilers are often commercial off-the-shelf sonars used to determine characteristics of the sea bottom and subbottom such as mud above bedrock or other rocky substrate. These operate at 2 to 7 kHz at source levels less than 210 dB re 1 μPa-m, and 35 to 45 kHz at less than 220 dB re 1 μPa-m.
- There are many sources of engine noise including but not limited to surface vessels, submarines, torpedoes, and other UUVs. The acoustic energy generally ranges from 50 Hz to 10 kHz at source levels less than 170 dB re 1 μPa-m. Targets, both mobile and stationary, may simulate engine noise at these same frequencies.

Additionally, a variety of surface vessels operate active acoustic depth sensors (fathometers) within the range sites, including Navy, private, and commercial vessels. In some cases, one or more frequencies are projected underwater. Bottom type, depth contours, and objects (*e.g.,* cables, sunken ships) can be located using this equipment. The depth sensors used by NUWC Keyport are the same fathometers used by commercial and recreational vessels for navigational safety. Because these instruments are widely used and are not found to adversely impact the human or natural environment, they are not analyzed further.

Range Activities: Testing That Involves Non-Acoustic Activities

(1) Magnetic

There are two types: (a) Magnetic sensors, and (b) magnetic sources. Magnetic sensors are passive and do not have a magnetic field associated with them. The sensors are bottom mounted, over the side (stationary or towed) or can be integrated into a UUV. They are used to sense the magnetic field of an object such as a surface vessel, a submarine, or a buried target. Magnetic sources are used to represent magnetic targets or are energized items such as power cables for energy generators (*e.g.* tidal). Magnetic sources generate electromagnetic fields (EMF). Evaluation of EMF (Navy 2008a) has shown that sources (*e.g.* Organic Airborne and Surface Influence Sweep (OASIS)) used are typically below 23 gauss (G) and are considered relatively minute strength.

(2) Oceanographic Sensor

These sensors have been used historically to determine marine characteristics such as conductivity, temperature, and pressure of water to determine sound velocity in water. This provides information about how sound will travel through the water. These sensors can be deployed over the side from a surface craft, suspended in water, or carried on a UUV.

(3) Laser Imaging Detection and Ranging (LIDAR)

Also known as light detection and ranging, LIDAR is used to measure distance, speed, rotation, and chemical composition and concentration of remote solid objects such as a ship or submerged object. LIDAR uses the same principle as radar. The LIDAR instrument transmits short pulses of laser light towards the target. The transmitted light interacts with and is changed by the target. Some of this light is reflected back to the instrument where it is analyzed. The change in the properties of the light enables some property of the target to be determined. The time it takes the light to travel to the target and back to the LIDAR can be used to determine the distance to the target. Since light attenuates rapidly in water, underwater LIDAR uses light in the blue-green part of the spectrum as it attenuates the least. Common civilian uses of LIDAR in the ocean include seabed mapping and fish detection. All safety issues associated with the use of lasers are evaluated for all applicable test activities within the range sites according to Navy and Federal regulations. This bounds the intensity of LIDAR used pursuant to this request to those systems that meet human safety standards.

(4) Inert Mine Hunting and Inert Mine Clearing Exercises

Associated with testing, a series of inert mine shapes are set out in a uniform or random pattern to test the detection, classification and localization capability of the system under test. They are made from plastic, metal, and concrete and vary in shape. An inert mine shape can measure about 10 by 1.75 ft (3 by 0.5 m) and weigh about 800 lbs (362 kg). Inert mine shapes either sit on the bottom or are tethered by an anchor to the bottom at various depths. Inert mine shapes can be placed approximately 200–300 yards (183–274 m) apart using a support craft and remain on the bottom until they need to be removed. All major components of all inert mine systems used as 'targets' for inert mine hunting systems are removed within 2 years.

NMFS does not believe that those Range activities that involve non-acoustic testing will have adverse impacts to marine mammals, therefore, they are not analyzed further and will not be covered under the proposed rule.

Increased Activities Due to Range Extension

The proposed range extension would expand the geographic area for all three range sites and increase the tempo of activities in the Keyport and QUTR ranges sites. A detailed list of the proposed annual range is provided in Table 3.

(1) Keyport Range Site

Range boundaries of the Keyport Range Site would be extended to the north, east and south, increasing the size of the range from 1.5 nm^2 to 3.2 nm^2 (5.1 km^2 to 11.0 km^2). The average annual days of use of the Keyport Range Site would increase from the current 55 days to 60 days.

(2) DBRC Site

The southern boundary of DBRC Site would be extended to the Hamma Hamma River and its northern boundary would be extended to 1 nm (2 km) south of the Hood Canal Bridge (Highway 104). This extension would increase the size of the current operating area from approximately 32.7 nm^2 (112.1 km^2) to approximately 45.7 nm^2 (150.8 km^2) and would afford a straight run of approximately 27.5 nm (50.9 km). There would be no change in the number and types of activities from the existing range activities at DBRC Site, and no increase in average annual days of use due to the range extension at this site.

(3) QUTR Site

Range boundaries of QUTR Site would be extended to coincide with the overlying special use airspace of W–237A plus a 7.8 nm^2 (26.6 km^2) surf zone at Pacific Beach. The total range area would increase from approximately 48.3 nm^2 (165.5 km^2) to approximately 1,839.8 nm^2 (6,310.2 km^2). The average annual number of days of use for offshore activities would increase from 14 days/year to 16 days/year in the offshore area. The average annual days of use for surf-zone activities would increase from 0 days/year to 30 days/year.

Table 3. Proposed Annual Range Activities and Operations

		Proposed Number of Activities/Year*		
Range Activity	Platform/System Used	Keyport Range Site	DBRC Site	QUTR Site
Test Vehicle Propulsion	Thermal propulsion systems	5	130	30
	Electric/Chemical propulsion systems	55	140	30
Other Testing Systems and Activities	Submarine testing	0	45	15
	Inert mine detection, classification and localization	5	20	10
	Non-Navy testing	5	5	5
	Acoustic & non-acoustic sensors (magnetic array, oxygen)	20	10	5
	Countermeasure test	5	50	5
	Impact testing	0	10	5
	Static in-water testing	10	10	6
	UUV test	45	120	40
	Unmanned Aerial System (UAS) test	0	2	2
Fleet Activities** (excluding RDT&E)	Surface Ship activities	1	10	10
	Aircraft activities	0	10	10
	Submarine activities	0	30	30
	Diver activities	45	5	15
Deployment Systems (RDT&E)	Range support vessels:			
	Surface launch craft	35	180	30
	Special purpose barges	25	75	0
	Fleet vessels***	15	20	20
	Aircraft (rotary and fixed wing)	0	10	20
	Shore and pier	45	30	30

* There may be several activities in 1 day. These numbers provide an estimate of types of range activities over the year.

** Fleet activities in the NAVSEA NUWC Keyport Range Complex do not include the use of surface ship and submarine hull-mounted active sonars.

*** As previously noted, Fleet vessels can include very small craft such as SEAL Delivery Vehicles.

Description of Marine Mammals in the Area of the Specified Activities

The information on marine mammals and their distribution and density are based on the data gathered from NMFS, United States Fish and Wildlife Service (USFWS) and recent references, literature searches of search engines, peer review journals, and other technical reports, to provide a regional context for each species. The data were compiled from available sighting records, literature, satellite tracking, and stranding and by-catch data.

A total of 24 cetacean species and subspecies and 5 pinniped species are known to occur in Washington State waters; however, several are seen only rarely. Seven of these marine mammal species are listed as Federally-endangered under the Endangered Species Act (ESA) occur or have the potential to occur in the proposed action area: blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), Sei whale (*B. borealis*), humpback whale (*Megaptera novaengliae*), north Pacific right whale (*Eubalaena japonica*), sperm whale (*Physeter macrocephalus*), and the southern resident population of killer whales (*Orcinus orca*). The species, Steller sea lion (*Eumetopias jubatus*), is listed as threatened under the ESA.

Survey data concerning the inland waters of Puget Sound are sparse. There have been few comprehensive studies of marine mammals in inland waters, and those that have occurred have focused on inland waters farther north (Strait of Juan de Fuca, San Juan/Gulf Islands, Strait of Georgia) (Osmek *et al.,* 1998). Most published information focuses on single species (*e.g.,* harbor seals, Jeffries *et al.,* 2003) or are stock assessment reports published by NMFS (*e.g.,* Carretta *et al.,* 2008).

Survey data for the offshore waters of Washington State, including the area of the QUTR Site, are somewhat better, particularly for cetaceans. The NMFS conducted vessel surveys in the region in 1996 and 2001, which are summarized in Barlow (2003) and Appler *et al.* (2004). Vessel surveys were again conducted by NMFS in summer 2005, and included finer-scale survey lines within the OCNMS (Forney, 2007). Cetacean densities from this most recent effort were used wherever possible; older density values (2001 or 1996) were used when more recent values were not available. Some cetacean densities (gray and killer whale, harbor porpoise) were obtained from sources other than the broad scale surveys indicated above and the methodologies of deriving the densities are included in the Navy's LOA application.

Pinniped at-sea density is not often available because pinniped abundance is most often obtained via shore counts of animals at known rookeries and haulouts. Therefore, densities of pinnipeds were derived differently from those of cetaceans. Several parameters were identified from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Determining density in this manner is risky as the parameters used usually contain error (*e.g.,* geographic range is not exactly known and needs to be estimated, abundance estimates usually have large variances) and, as is true of all density estimates, they assume that animals are always distributed evenly within an area, which is likely rarely true. However, this remains one of the few means available to determine at-sea density for pinnipeds.

Sea otters occur along the northern Washington coast. Density of sea otters was published as animals/km, which was modified to provide density per area. Since sea otters are under the U.S. Fish and Wildlife Service jurisdiction, they are not considered in this document.

The following are brief descriptions of the temporal and spatial distribution and abundance of marine mammals throughout the NAVSEA NUWC Keyport Range Complex Extension.

Keyport Range Site

A total of five cetaceans and three pinnipeds are known to occur within central Puget Sound, which encompasses the Keyport action area, but several of these species have never been observed in Port Orchard Narrows or in the action area (Table 4). Humpback whales, minke whales, killer whales, and Steller sea lions are expected to be uncommon to rare in southern Puget Sound and have never been seen in the Keyport action area. Density estimates for these species are available for Puget Sound as a whole, but since these species have never been recorded or observed in the action area, the densities for the action area are shown as ''0'' to reflect this. The proposed extension area of the Keyport Range Site is listed as critical habitat for Southern Resident killer whales. The current Keyport Range Site is outside the critical habitat area.

Table 4. Marine Mammal Known to Occur or Potentially Occur within the Keyport Action Area

Species		ESA/MMP Status	Occurrence in Keyport Action Area	Density Estimate (km^3) Warm Season	Density Estimate (km^3) Cold Season
CETACEAN					
Mysticetes					
Minke whale		- / -	Very rare, year round.	0[a]	0[a]
Humpback whale		E/D	Very rare, warm season; has never been recorded in action area.	0[a]	0[a]
Gray whale		- / -	Very rare, migrant and summer/fall resident population in primarily northern Puget Sound	0[a]	0[a]
Odontocetes					
Killer whale	Transient	- / -	Very rare, year round; has never been recorded in action area	0[a]	0[a]
Killer whale	S. Resident	E, CH/D	Very rare, summer/fall season; has never been recorded in action area.	0[a]	0[a]
Dall's porpoise		- / -	Rare, year round.	0[a]	0[a]
PINNIPEDS					
Harbor seal		- / -	Common year-round resident.	0.55	0.55
California sea lion		- / -	Rare, cold season.	0[a]	0[a]
Steller sea lion		T/D	Rare, cold season; has never been recorded in action area	0[a]	0[a]

Notes: D = Depleted, E = Endangered, CH = Critical Habitat, T = Threatened.
Warm season = May-October, Cold season = November-April.
abundant = the species is expected to be encountered during a single visit to the area and the number of individuals encountered during an average visit may be as many as hundreds or more; common = the species is expected to be encountered once or more during 2-3 visits to the area and the number of individuals encountered during an average visit is unlikely to be more than a few 10s; uncommon = the species is expected to be encountered at most a few times a year; rare = the species is not expected to be encountered more than once in several years; very rare = not expected to be encountered more than once in 10 years.
[a] Density estimates for these species were calculated for Puget Sound as a whole, but these species have never been recorded or observed in the action area. Thus the densities for the action area are shown as "0" to reflect this.

DBRC Site

Six cetaceans and three pinnipeds are known to occur or potentially occur within the DBRC action area (Table 5). Density estimates for these species are available for Puget Sound as a whole, but since these species have never been recorded or observed in the action area, the densities for the action area are shown as ''0'' to reflect this. There is no designated or proposed critical habitat for marine mammals within the DBRC action area.

Table 5. Marine Mammal Known to Occur or Potentially Occur within the DBRC Action Area

Species		ESA/MMP Status	Occurrence in Keyport Action Area	Density Estimate (km^3)	
				Warm Season	Cold Season
CETACEAN					
Mysticetes					
Minke whale		- / -	Very rare, year round; has never been recorded in action area.	0[(a)]	0[(a)]
Humpback whale		E/D	Very rare, warm season; has never been recorded in action area.	0[(a)]	0[(a)]
Gray whale		- / -	Very rare, spring/fall migrant and summer/fall resident population in primarily northern Puget Sound	0[(a)]	0[(a)]
Odontocetes					
Killer whale	Transient	- / -	Uncommon, spring/summer	Jan-Jun: 0.038	Jul-Dec: 0
	S. Resident	E/D	Very rare, no recorded occurrence in Hood Canal.	0[(a)]	0[(a)]
Dall's porpoise		- / -	Very rare, year round.	0	0
PINNIPEDS					
Harbor seal		- / -	Common year-round resident.	1.31	1.31
California sea lion		- / -	Common resident and seasonal migrant.	0[(a)]	0.052
Steller sea lion		T/D	Very rare, cold season; has never been recorded in action area	0[(a)]	0[(a)]

Notes: D = Depleted, E = Endangered, CH = Critical Habitat, T = Threatened.
Warm season = May-October, Cold season = November-April.
abundant = the species is expected to be encountered during a single visit to the area and the number of individuals encountered during an average visit may be as many as hundreds or more; common = the species is expected to be encountered once or more during 2-3 visits to the area and the number of individuals encountered during an average visit is unlikely to be more than a few 10s; uncommon = the species is expected to be encountered at most a few times a year; rare = the species is not expected to be encountered more than once in several years; very rare = not expected to be encountered more than once in 10 years.
[(a)] These species have never been recorded or observed in the action area. Thus the densities for the action area are shown as "0" to reflect this.

3.2.3 QUTR Site

The diversity of marine mammals that occur in QUTR is greater than that in the Puget Sound ranges and is listed in Table 6.

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Table 6. Marine Mammal Known to Occur or Potentially Occur within the QUTR Action Area

Species		ESA/MMP Status	Occurrence in Keyport Action Area	Density Estimate (km^3)	
				Warm Season	Cold Season
CETACEAN					
Mysticetes					
Blue whale		E/D	Rare, warm season	0.0003	0
Fin whale		E/D	Rare, year-round	0.0012	0.0012
Gray whale	Resident	- / -	Uncommon, year-round	0.003	0.003
	Migratory	- / -	Abundant briefly during cold season migration	0	NA
Humpback whale		E/D	Uncommon, warm season	0.0237	0
Minke whale		- / -	Rare, year-round	0.0004	0.0004
North Pacific right Whale		E/D	Very rare, warm season	0[(a)]	0[(a)]
Sei whale		E/D	Very rare, year-round	0.0002	0.0002
Odontocetes					
Baird's beaked whale		- / -	Uncommon, year-round	0.0027	0.0027
Hubb's & Stejneger's beaked whale		- / -	Uncommon, year-round	0.0027	0.0027
Dall's porpoise		- / -	Abundant, year-round	0.1718	0.1718
Harbor porpoise		- / -	Abundant, year-round	2.86	2.86
Northern right whale dolphin		- / -	Common, year-round	0.0419	0.0419
Pacific white-sided dolphin		- / -	Abundant, warm season	0.1929	0
Risso's dolphin		- / -	Uncommon, year-round	0.002	0.002
Short-beaked common dolphin		- / -	Uncommon, warm season	0.0012	0
Striped dolphin		- / -	Very rare, year-round	0.0002	0
Dwarf & pygmy sperm whales		- / -	Uncommon, warm season	0.0015	0
Sperm whale		E/D	Uncommon, warm season	0.0011	0.0011
Killer whale	N. Resident	- / -	Rare, year-round	0.0028	0.0028
	S. Resident	E/D	Rare, year-round		
	Offshore	- / -	Uncommon, year-round		
	Transient	- / -	Uncommon, cold season		
PINNIPEDS					
Phocids					
Harbor seal		- / -	Abundant, year-round	0.44	0.44
Northern elephant seal		- / -	Uncommon, year-round	Dec-Feb: 0.019 Mar-Apr: 0.026 May-Jul: 0.038 Aug-Nov: 0.047	
Otariids					
California sea lion		- / -	Common, year-round except May-July.	Aug-Apr: 0.283 May-Jul: 0	
Northern fur seal		- /D	Common, year-round	0.091	0.117
Steller sea lion		T/D	Uncommon, year-round	0.0096	0.0096

MUSTELIDS				
Sea otter	- / -	Does not presently occur within the action area	0[a]	0[a]

Notes: D = Depleted, E = Endangered, CH = Critical Habitat, T = Threatened.
Warm season = May-October, Cold season = November-April.
abundant = the species is expected to be encountered during a single visit to the area and the number of individuals encountered during an average visit may be as many as hundreds or more; common = the species is expected to be encountered once or more during 2-3 visits to the area and the number of individuals encountered during an average visit is unlikely to be more than a few 10s; uncommon = the species is expected to be encountered at most a few times a year; rare = the species is not expected to be encountered more than once in several years; very rare = not expected to be encountered more than once in 10 years.
[a] These species have never been recorded or observed in the action area. Thus the densities for the action area are shown as "0" to reflect this.

More detailed description of marine mammal density estimates within the NAVSEA NUWC Keyport Range Complex Extension is provided in the Navy's LOA application.

A Brief Background on Sound

An understanding of the basic properties of underwater sound is necessary to comprehend many of the concepts and analyses presented in this document. A summary is included below.

Sound is a wave of pressure variations propagating through a medium (for the sonar considered in this proposed rule, the medium is marine water). Pressure variations are created by compressing and relaxing the medium. Sound measurements can be expressed in two forms: intensity and pressure. Acoustic intensity is the average rate of energy transmitted through a unit area in a specified direction and is expressed in watts per square meter (W/m^2). Acoustic intensity is rarely measured directly, it is derived from ratios of pressures; the standard reference pressure for underwater sound is 1 microPascal (microPa); for airborne sound, the standard reference pressure is 20 microPa (Urick, 1983).

Acousticians have adopted a logarithmic scale for sound intensities, which is denoted in decibels (dB). Decibel measurements represent the ratio between a measured pressure value and a reference pressure value (in this case 1 microPa or, for airborne sound, 20 microPa). The logarithmic nature of the scale means that each 10 dB increase is a tenfold increase in power (*e.g.,* 20 dB is a 100-fold increase, 30 dB is a 1,000-fold increase). Humans perceive a 10-dB increase in noise as a doubling of sound level, or a 10 dB decrease in noise as a halving of sound level. The term "sound pressure level" implies a decibel measure and a reference pressure that is used as the denominator of the ratio. Throughout this document, NMFS uses 1 microPa as a standard reference pressure unless noted otherwise.

It is important to note that decibels underwater and decibels in air are not the same and cannot be directly compared. To estimate a comparison between sound in air and underwater, because of the different densities of air and water and the different decibel standards (*i.e.,* reference pressures) in water and air, a sound with the same intensity (*i.e.,* power) in air and in water would be approximately 61.5 dB lower in air. Thus, a sound that is 160 dB loud underwater would have the same approximate effective intensity as a sound that is 98.5 dB loud in air.

Sound frequency is measured in cycles per second, or Hertz (abbreviated Hz), and is analogous to musical pitch; high-pitched sounds contain high frequencies and low-pitched sounds contain low frequencies. Natural sounds in the ocean span a huge range of frequencies: from earthquake noise at 5 Hz to harbor porpoise clicks at 150,000 Hz (150 kHz). These sounds are so low or so high in pitch that humans cannot even hear them; acousticians call these infrasonic and ultrasonic sounds, respectively. A single sound may be made up of many different frequencies together. Sounds made up of only a small range of frequencies are called "narrowband", and sounds with a broad range of frequencies are called "broadband"; airguns are an example of a broadband sound source and tactical sonars are an example of a narrowband sound source.

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms derived using auditory evoked potential, anatomical modeling, and other data, Southall *et al.* (2007) designated "functional hearing groups" and estimated the lower and upper frequencies of functional hearing of the groups. Further, the frequency range in which each group's hearing is estimated as being most sensitive is represented in the flat part of the M-weighting functions developed for each group. The functional groups and the associated frequencies are indicated below:

- Low frequency cetaceans (13 species of mysticetes): Functional hearing is estimated to occur between approximately 7 Hz and 22 kHz.
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz.
- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, *Kogia,* the franciscana, and four species of cephalorhynchids): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz.
- Pinnipeds in Water: Functional hearing is estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz.
- Pinnipeds in Air: Functional hearing is estimated to occur between approximately 75 Hz and 30 kHz.

Because ears adapted to function underwater are physiologically different from human ears, comparisons using decibel measurements in air would still not be adequate to describe the effects of a sound on a cetacean. When sound travels away from its source, its loudness decreases as the distance from the source increases (propagation). Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer distant. Acousticians often refer to the loudness of a sound at its source (typically measured one meter from the source) as the source level and the loudness of sound elsewhere as the received level. For example, a humpback whale three kilometers from an airgun that has a source level of 230 dB may only be exposed to sound that is 160 dB loud, depending on how the sound propagates. As a result, it is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean.

As sound travels from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. The physical characteristics that determine the sound's speed through the water will change with depth, season, geographic location, and with time of day (as a result, in actual sonar operations, crews will measure oceanic conditions, such as sea water temperature and depth, to calibrate models that determine the path the sonar signal will take as it travels through the ocean and how strong the sound signal will be at a given range along a particular transmission path). As sound travels through the ocean, the intensity associated with the wavefront diminishes, or attenuates. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss.

Metrics Used in This Document

This section includes a brief explanation of the two sound measurements (sound pressure level (SPL) and sound exposure level (SEL)) frequently used in the discussions of acoustic effects in this document.

SPL

Sound pressure is the sound force per unit area, and is usually measured in microPa, where 1 Pa is the pressure resulting from a force of one newton exerted over an area of one square meter. SPL is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in underwater acoustics is 1 microPa, and the units for SPLs are dB re: 1 microPa.

SPL (in dB) = 20 log (pressure/reference pressure)

SPL is an instantaneous measurement and can be expressed as the peak, the peak-peak, or the root mean square (rms). Root mean square, which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates. All references to SPL in this document refer to the root mean square. SPL does not take the duration of a sound into account. SPL is the applicable metric used in the risk continuum, which is used to estimate behavioral harassment takes (*see* Level B Harassment Risk Function (Behavioral Harassment) Section).

SEL

SEL is an energy metric that integrates the squared instantaneous sound pressure over a stated time interval. The units for SEL are dB re: 1 $microPa^2$-s.

SEL = SPL + 10log (duration in seconds)

As applied to tactical sonar, the SEL includes both the SPL of a sonar ping and the total duration. Longer duration pings and/or pings with higher SPLs will have a higher SEL. Surface-ship hull-mounted sonars, known as tactical sonars, are not used by NAVSEA NUWC Keyport. If an animal is exposed to multiple pings, the SEL in each individual ping is summed to calculate the total SEL. The total SEL depends on the SPL, duration, and number of pings received. The thresholds that NMFS uses to indicate the received levels at which the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in hearing are likely to occur are expressed in SEL.

Potential Impacts to Marine Mammal Species

The following sections discuss the potential effects from noise related to active acoustic devices that would be used in the proposed Keyport Range Complex Extension.

For activities involving active acoustic sources such as tactical sonar, NMFS's analysis identifies the probability of lethal responses, physical trauma, sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral disturbance (that rises to the level of harassment), and social responses that would be classified as behavioral harassment or injury and/or would be likely to adversely affect the species or stock through effects on annual rates of recruitment or survival. It should be noted that the description below is based on more powerful mid-frequency active sonar (MFAS) used on surface ships. The NAVSEA NUWC Keyport Range does not utilize these sources in RDT&E activities. Many of these severe effects (*e.g.,* mortality, acoustically mediated bubble growth, and stranding) are not likely to occur for acoustic sources used in the proposed Keyport Range activities, as shown in Estimated Takes of Marine Mammals section.

Direct Physiological Effects

Based on the literature, there are two basic ways that MFAS might directly result in physical trauma or damage: Noise-induced loss of hearing sensitivity (more commonly-called ''threshold shift'') and acoustically mediated bubble growth. Separately, an animal's behavioral reaction to an acoustic exposure might lead to physiological effects that might ultimately lead to injury or death, which is discussed later in the Stranding section.

Threshold Shift (Noise-Induced Loss of Hearing)

When animals exhibit reduced hearing sensitivity (*i.e.,* sounds must be louder for an animal to recognize them) following exposure to a sufficiently intense sound, it is referred to as a noise-induced threshold shift (TS). An animal can experience temporary threshold shift (TTS) or permanent threshold shift (PTS). TTS can last from minutes or hours to days (*i.e.,* there is recovery), occurs in specific frequency ranges (*i.e.,* an animal might only have a temporary loss of hearing sensitivity between the frequencies of 1 and 10 kHz)), and can be of varying amounts (for example, an animal's hearing sensitivity might be reduced by only 6 dB or reduced by 30 dB). PTS is permanent (*i.e.,* there is no recovery), but as with TTS occurs in a specific frequency range and amount.

The following physiological mechanisms are thought to play a role in inducing auditory TSs: Effects to sensory hair cells in the inner ear that reduce their sensitivity, modification of the chemical environment within the sensory cells, residual muscular activity in the middle ear, displacement of certain inner ear membranes, increased blood flow, and post-stimulatory reduction in both efferent and sensory neural output (Southall *et al.,* 2007). The amplitude, duration, frequency, temporal pattern, and energy distribution of sound exposure all affect the amount of associated TS and the frequency range in which it occurs. As amplitude and duration of sound exposure increase, so, generally, does the amount of TS. For continuous sounds, exposures of equal energy (the same SEL) will lead to approximately equal effects. For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter *et al.,* 1966; Ward, 1997). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter, 1985) (although in the case of MFAS, animals are not expected to be exposed to levels high enough or durations long enough to result in PTS).

PTS is considered auditory injury (Southall *et al.,* 2007). Irreparable damage to the inner or outer cochlear hair cells may cause PTS, however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.,* 2007).

Although the published body of scientific literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a loud sound, only a few studies provide empirical information on the levels at which noise-induced loss in hearing sensitivity occurs in nonhuman animals. For cetaceans, published data are limited to a captive bottlenose dolphin and beluga whale (Finneran *et al.,* 2000, 2002b, 2005a; Schlundt *et al.,* 2000; Nachtigall *et al.,* 2003, 2004).

Marine mammal hearing plays a critical role in communication with conspecific, and interpreting environmental cues for purposes such as predator avoidance and prey capture. Depending on the frequency range of TTS degree (dB), duration, and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious (similar to those discussed in auditory masking, below). For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that takes place during a time when the animal is traveling through the open ocean, where ambient noise is lower and there are not as many competing sounds present.

Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts. Also, depending on the degree and frequency range, the effects of PTS on an animal could range in severity, although it is considered generally more serious because it is a long term condition. Of note, reduced hearing sensitivity as a simple function of development and aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.,* 2007), so we can infer that strategies exist for coping with this condition to some degree, though likely not without cost. There is no empirical evidence that exposure to MFAS can cause PTS in any marine mammals; instead the probability of PTS has been inferred from studies of TTS (see Richardson *et al.,* 1995).

Acoustically Mediated Bubble Growth

One theoretical cause of injury to marine mammals is rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process could be facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). The deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser *et al.,* 2001b). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. Recent work conducted by Crum *et al.* (2005) demonstrated the possibility of rectified diffusion for short duration signals, but at sound exposure levels and tissue saturation levels that are improbable to occur in a diving marine mammal. However, an alternative but related hypothesis has also been suggested: Stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. Yet another hypothesis (decompression sickness) has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson *et al.,* 2003; Fernandez *et al.,* 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Collectively, these hypotheses can be referred to as ''hypotheses of acoustically mediated bubble growth.''

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). Crum and Mao (1996) hypothesized that received levels would have to exceed 190 dB in order for there to be the possibility of significant bubble growth due to supersaturation of gases in the blood (*i.e.,* rectified diffusion). More recent work conducted by Crum *et al.* (2005) demonstrated the possibility of rectified diffusion for short duration signals, but at SELs and tissue saturation levels that are highly improbable to occur in diving marine mammals. To date, Energy Levels (ELs) predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated (NOAA, 2002b). Although it has been argued that traumas from some recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.,* 2003), there is no conclusive evidence of this. However, Jepson *et al.* (2003, 2005) and Fernandez *et al.* (2004, 2005) concluded that in vivo bubble formation, which may be exacerbated by deep, long duration, repetitive dives may explain why beaked whales appear to be particularly vulnerable to sonar exposures. Further investigation is needed to further assess the potential validity of these hypotheses. More information regarding hypotheses that attempt to explain how behavioral responses to MFAS can lead to strandings is included in the Behaviorally Mediated Bubble Growth section, after the summary of strandings.

Acoustic Masking

Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, and learning about their environment (Erbe and Farmer, 2000; Tyack, 2000). Masking, or auditory interference, generally occurs when sounds in the environment are louder than and of a similar frequency to, auditory signals an animal is trying to receive. Masking is a phenomenon that affects animals that are trying to receive acoustic information about their environment, including sounds from other members of their species, predators, prey, and sounds that allow them to orient in their environment. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

The extent of the masking interference depends on the spectral, temporal, and spatial relationships between the signals an animal is trying to receive and the masking noise, in addition to other factors. In humans, significant masking of tonal signals occurs as a result of exposure to noise in a narrow band of similar frequencies. As the sound level increases, though, the detection of frequencies above those of the masking stimulus decreases also. This principle is expected to apply to marine mammals as well because of common biomechanical cochlear properties across taxa.

Richardson *et al.* (1995) argued that the maximum radius of influence of an industrial noise (including broadband low frequency sound transmission) on a marine mammal is the distance from the source to the point 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 present. Industrial masking is most likely to affect some species' ability to detect communication calls and natural sounds (*i.e.,* surf noise, prey noise, etc.; Richardson *et al.,* 1995).

The echolocation calls of odontocetes (toothed whales) are subject to masking by high frequency sound. Human data indicate low frequency sound can mask high frequency sounds (*i.e.,* upward masking). Studies on captive odontocetes by Au *et al.* (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (*e.g.,* adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high frequencies these cetaceans use to echolocate, but not at the low-to moderate frequencies they use to communicate (Zaitseva *et al.,* 1980).

As mentioned previously, the functional hearing ranges of marine mammals all encompass the frequencies of the active acoustic sources used in the Navy's Keyport Range activities. Additionally, almost all species' vocal repertoires span across the frequencies of the sources used by the Navy. The closer the characteristics of the masking signal to the signal of interest, the more likely masking is to occur. However, because the pulse length and duty cycle of source signals are of short duration and would not be continuous, masking is unlikely to occur as a result of exposure to active acoustic sources during the RDT&E activities in the Keyport Range Complex Extension Study Area.

Impaired Communication

In addition to making it more difficult for animals to perceive acoustic cues in their environment, anthropogenic sound presents separate challenges for animals that are vocalizing. When they vocalize, animals are aware of environmental conditions that affect the ''active space'' of their vocalizations, which is the maximum area within which their vocalizations can be detected before it drops to the level of ambient noise (Brenowitz, 2004; Brumm *et al.,* 2004; Lohr *et al.,* 2003). Animals are also aware of environmental conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which are more important than detecting a vocalization (Brenowitz, 1982; Brumm *et al.,* 2004; Dooling, 2004; Marten and Marler, 1977; Patricelli *et al.,* 2006). Most animals that vocalize have evolved an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability of their vocalizations in the face of temporary changes in background noise (Brumm *et al.,* 2004; Patricelli *et al.,* 2006). Vocalizing animals will make one or more of the following adjustments to their vocalizations: Adjust the frequency structure; adjust the amplitude; adjust temporal structure; or adjust temporal delivery.

Many animals will combine several of these strategies to compensate for high levels of background noise. Anthropogenic sounds that reduce the signal-to-noise ratio of animal vocalizations, increase the masked auditory thresholds of animals listening for such vocalizations, or reduce the active space of an animal's vocalizations impair communication between animals. Most animals that vocalize have evolved strategies to compensate for the effects of short-term or temporary increases in background or ambient noise on their songs or calls. Although the fitness consequences of these vocal adjustments remain unknown, like most other trade-offs animals must make, some of these strategies probably come at a cost (Patricelli *et al.,* 2006). For example, vocalizing more loudly in noisy environments may have energetic costs that decrease the net benefits of vocal adjustment and alter a bird's energy budget (Brumm, 2004; Wood and Yezerinac, 2006). Shifting songs and calls to higher frequencies may also impose energetic costs (Lambrechts, 1996).

Stress Responses

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky *et al.,* 2005; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: Behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune response.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the autonomic nervous system and the classical ''fight or flight'' response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with ''stress.'' These responses have a relatively short duration and may or may not have significant long-term effects on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier, 1995) and altered metabolism (Elasser *et al.,* 2000), reduced immune competence (Blecha, 2000) and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; Romano *et al.,* 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and its fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called ''distress'' (sensu Seyle, 1950) or ''allostatic loading'' (sensu McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiments; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005; Reneerkens *et al.,* 2002; Thompson and Hamer, 2000). Although no information has been collected on the physiological responses of marine mammals to exposure to anthropogenic sounds, studies of other marine animals and terrestrial animals would lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as ''distress'' upon exposure to mid-frequency and low frequency sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (for example, elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) identified noise induced physiological transient stress responses in hearing-specialist fish that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses cetaceans use to gather information about their environment and to communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on cetaceans remains limited, it seems reasonable to assume that reducing an animal's ability to gather information about its environment and to communicate with other members of its species would be stressful for animals that use hearing as their primary sensory mechanism. Therefore, we assume that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses because terrestrial animals exhibit those responses under similar conditions (NRC, 2003). More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg, 2000), we also assume that stress responses are likely to persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

Behavioral Disturbance

Behavioral responses to sound are highly variable and context-specific. Exposure of marine mammals to sound sources can result in (but is not limited to) the following observable responses: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.,* 2007).

Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound type affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately pre-disposed to respond to certain sounds in certain ways) (Southall *et al.,* 2007). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.,* calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.,* 2007). Individuals (of different age, gender, reproductive status, etc.) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.,* proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone.

There are few empirical studies of avoidance responses of free-living cetaceans to mid-frequency sonars. Much more information is available on the avoidance responses of free-living cetaceans to other acoustic sources, like seismic airguns and low frequency sonar, than mid-frequency active sonar. Richardson *et al.,* (1995) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals.

Behavioral Responses (Southall et al. (2007))

Southall *et al.,* (2007) reports the results of the efforts of experts in acoustic research from behavioral, physiological, and physical disciplines that convened and reviewed the available literature on marine mammal hearing and physiological and behavioral responses to anthropogenic sound with the goal of proposing exposure criteria for certain effects. This compilation of literature is very valuable, though Southall *et al.* notes that not all data is equal: Some have poor statistical power, insufficient controls, and/or limited information on received levels, background noise, and other potentially important contextual variables; such data were reviewed and sometimes used for qualitative illustration, but were not included in the quantitative analysis for the criteria recommendations.

In the Southall *et al.,* (2007) report, for the purposes of analyzing responses of marine mammals to anthropogenic sound and developing criteria, the authors differentiate between single pulse sounds, multiple pulse sounds, and non-pulse sounds. Sonar signal is considered a non-pulse sound. Southall *et al.,* (2007) summarize the reports associated with low, mid, and high frequency cetacean responses to non-pulse sounds in Appendix C of their report (incorporated by reference and summarized in the three paragraphs below).

The reports that address responses of low frequency cetaceans to non-pulse sounds include data gathered in the field and related to several types of sound sources (of varying similarity to sonar signals) including: Vessel noise, drilling and machinery playback, low frequency M-sequences (sine wave with multiple phase reversals) playback, low frequency active sonar playback, drill vessels, Acoustic Thermometry of Ocean Climate (ATOC) source, and non-pulse playbacks. These reports generally indicate no (or very limited) responses to received levels in the 90 to 120 dB re 1 micro Pa range and an increasing likelihood of avoidance and other behavioral effects in the 120 to 160 dB range. As mentioned earlier, however, contextual variables play a very important role in the reported responses, and the severity of effects are not linear when compared to received level. Also, few of the laboratory or field datasets had common conditions, behavioral contexts or sound sources, so it is not surprising that responses differ.

The reports that address responses of mid-frequency cetaceans to non-pulse sounds include data gathered both in the field and the laboratory and related to several different sound sources (of varying similarity to sonar signals) including: Pingers, drilling playbacks, vessel and ice-breaking noise, vessel noise, Acoustic Harassment Devices (AHDs), Acoustic Deterrent Devices (ADDs), HFAS/MFAS, and non-pulse bands and tones. Southall *et al.* were unable to come to a clear conclusion regarding these reports. In some cases, animals in the field showed significant responses to received levels between 90 and 120 dB, while in other cases these responses were not seen in the 120 to 150 dB range. The disparity in results was likely due to contextual variation and the differences between the results in the field and laboratory data (animals responded at lower levels in the field).

The reports that address the responses of high frequency cetaceans to non-pulse sounds include data gathered both in the field and the laboratory and related to several different sound sources (of varying similarity to sonar signals) including: Acoustic harassment devices, Acoustical Telemetry of Ocean Climate (ATOC), wind turbine, vessel noise, and construction noise. However, no conclusive results are available from these reports. In some cases, high frequency cetaceans (harbor porpoises) are observed to be quite sensitive to a wide range of human sounds at very low exposure RLs (90 to 120 dB). All recorded exposures exceeding 140 dB produced profound and sustained avoidance behavior in wild harbor porpoises (Southall *et al.,* 2007).

In addition to summarizing the available data, the authors of Southall *et al.* (2007) developed a severity scaling system with the intent of ultimately being able to assign some level of biological significance to a response. Following is a summary of their scoring system: A comprehensive list of the behaviors associated with each score may be found in the report:

- 0–3 (Minor and/or brief behaviors) includes, but is not limited to: No response; minor changes in speed or locomotion (but with no avoidance); individual alert behavior; minor cessation in vocal behavior; minor changes in response to trained behaviors (in laboratory).
- 4–6 (Behaviors with higher potential to affect foraging, reproduction, or survival) includes, but is not limited to: Moderate changes in speed, direction, or dive profile; brief shift in group distribution; prolonged cessation or modification of vocal behavior (duration > duration of sound), minor or moderate individual and/or group avoidance of sound; brief cessation of reproductive behavior; or refusal to initiate trained tasks (in laboratory).
- 7–9 (Behaviors considered likely to affect the aforementioned vital rates) includes, but are not limited to: Extensive of prolonged aggressive behavior; moderate, prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms; long-term avoidance of an area; outright panic, stampede, stranding; threatening or attacking sound source (in laboratory).

In Table 7 we have summarized the scores that Southall *et al.* (2007) assigned to the papers that reported behavioral responses of low frequency cetaceans, mid-frequency cetaceans, and high frequency cetaceans to non-pulse sounds.

TABLE 7—DATA COMPILED FROM THREE TABLES FROM SOUTHALL ET AL. (2007) INDICATING WHEN MARINE MAMMALS (LOW-FREQUENCY CETACEAN = L, MID-FREQUENCY CETACEAN = M, AND HIGH-FREQUENCY CETACEAN = H) WERE REPORTED AS HAVING A BEHAVIORAL RESPONSE OF THE INDICATED SEVERITY TO A NON-PULSE SOUND OF THE INDICATED RECEIVED LEVEL

[As discussed in the text, responses are highly variable and context specific]

Received RMS sound pressure level (dB re 1 microPa)	Response Score											
	80 to <90	90 to < 100	100 to < 110	110 to <120	120 to < 130	130 to < 140	140 to < 150	150 to < 160	160 to < 170	170 to < 180	180 to < 190	190 to < 200
9	...	...	...	...	...	...	...	...	...	...	...	...
8	...	M	M	...	M	...	M	...	...	...	M	M
7	...	...	...	...	...	L	L	...	...	...	...	...
6	H	L/H	L/H	L/M/H	L/M/H	L	L/H	H	M/H	M	...	...
5	...	...	...	...	M	...	...	...	...	...	...	...
4	...	...	H	L/M/H	L/M	...	L	...	...	...	...	...
3	...	M	L/M	L/M	M	...	...	...	...	...	...	...
2	...	...	L	L/M	L	L	L	...	...	...	...	...
1	...	...	M	M	M	...	...	...	...	...	...	...
0	L/H	L/H	L/M/H	L/M/H	L/M/H	L	M	...	...	...	M	M

Potential Effects of Behavioral Disturbance

The different ways that marine mammals respond to sound are sometimes indicators of the ultimate effect that exposure to a given stimulus will have on the well-being (survival, reproduction, etc.) of an animal. There is little marine mammal data quantitatively relating the exposure of marine mammals to sound to effects on reproduction or survival, though data exist for terrestrial species from which we can draw comparisons for marine mammals.

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called ''attentional capture'' occurs when a stimulus (such as a stimulus that an animal is not concentrating on or attending to) ''captures'' an animal's attention. This shift in attention can occur consciously or unconsciously (for example, when an animal hears sounds that it associates with the approach of a predator) and the shift in attention can be sudden (Dukas, 2002; van Rij, 2007). Once a stimulus has captured an animal's attention, the animal can respond by ignoring the stimulus, assuming a ''watch and wait'' posture, or treat the stimulus as a disturbance and respond accordingly, which includes scanning for the source of the stimulus or ''vigilance'' (Cowlishaw *et al.,* 2004).

Vigilance is normally an adaptive behavior that helps animals determine the presence or absence of predators, assess their distance from conspecifics, or to attend cues from prey (Bednekoff and Lima, 1998; Treves, 2000). Despite those benefits, however, vigilance has a cost of time: When animals focus their attention on specific environmental cues, they are not attending to other activities such as foraging. These costs have been documented best in foraging animals, where vigilance has been shown to substantially reduce feeding rates (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002).

Animals will spend more time being vigilant, which may translate to less time foraging or resting, when disturbance stimuli approach them more directly, remain at closer distances, have a greater group size (for example, multiple surface vessels), or when they co-occur with times that an animal perceives increased risk (for example, when they are giving birth or accompanied by a calf). Most of the published literature, however, suggests that direct approaches will increase the amount of time animals will dedicate to being vigilant. For example, bighorn sheep and Dall's sheep dedicated more time being vigilant, and less time resting or foraging, when aircraft made direct approaches over them (Frid, 2001; Stockwell *et al.,* 1991).

Several authors have established that long-term and intense disturbance stimuli can cause population declines by reducing the body condition of individuals that have been disturbed, followed by reduced reproductive success, reduced survival, or both (Daan *et al.,* 1996; Madsen, 1994; White, 1983). For example, Madsen (1994) reported that pink-footed geese (*Anser brachyrhynchus*) in undisturbed habitat gained body mass and had about a 46-percent reproductive success compared with geese in disturbed habitat (being consistently scared off the fields on which they were foraging) which did not gain mass and had a 17 percent reproductive success. Similar reductions in reproductive success have been reported for mule deer (*Odocoileus hemionus*) disturbed by all-terrain vehicles (Yarmoloy *et al.,* 1988), caribou disturbed by seismic exploration blasts (Bradshaw *et al.,* 1998), caribou disturbed by low-elevation military jetfights (Luick *et al.,* 1996), and caribou disturbed by low-elevation jet flights (Harrington and Veitch, 1992). Similarly, a study of elk (*Cervus elaphus*) that were disturbed experimentally by pedestrians concluded that the ratio of young to mothers was inversely related to disturbance rate (Phillips and Alldredge, 2000).

The primary mechanism by which increased vigilance and disturbance appear to affect the fitness of individual animals is by disrupting an animal's time budget and, as a result, reducing the time they might spend foraging and resting (which increases an animal's activity rate and energy demand). For example, a study of grizzly bears (*Ursus horribilis*) reported that bears disturbed by hikers reduced their energy intake by an average of 12 kcal/min (50.2×103 kJ/min), and spent energy fleeing or acting aggressively toward hikers (White *et al.,* 1999).

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hr cycle). Substantive behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007).

Stranding and Mortality

When a live or dead marine mammal swims or floats onto shore and becomes ''beached'' or incapable of returning to sea, the event is termed a ''stranding'' (Geraci *et al.,* 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding within the United States is that ''(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.'' (16 U.S.C. 1421h).

Marine mammals are known to strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most stranding are unknown (Geraci *et al.,* 1976; Eaton, 1979, Odell *et al.,* 1980; Best, 1982). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to these phenomena. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.,* 2003; Fair and Becker, 2000; Foley *et al.,* 2001; Moberg, 2000; Relyea, 2005a; 2005b, Romero, 2004; Sih *et al.,* 2004).

Several sources have published lists of mass stranding events of cetaceans during attempts to identify relationships between those stranding events and military sonar (Hildebrand, 2004; IWC, 2005; Taylor *et al.,* 2004). For example, based on a review of stranding records between 1960 and 1995, the International Whaling Commission (IWC, 2005) identified ten mass stranding events of Cuvier's beaked whales that had been reported and one mass stranding of four Baird's beaked whales (*Berardius bairdii*). The IWC concluded that, out of eight stranding events reported from the mid-1980s to the summer of 2003, seven had been associated with the use of mid-frequency sonar, one of those seven had been associated with the use of low frequency sonar, and the remaining stranding event had been associated with the use of seismic airguns.

Most of the stranding events reviewed by the IWC involved beaked whales. A mass stranding of Cuvier's beaked whales in the eastern Mediterranean Sea occurred in 1996 (Frantzis, 1998) and mass stranding events involving Gervais' beaked whales, Blainville's beaked whales, and Cuvier's beaked whales occurred off the coast of the Canary Islands in the late 1980s (Simmonds and Lopez-Jurado, 1991). The stranding events that occurred in the Canary Islands and Kyparissiakos Gulf in the late 1990s and the Bahamas in 2000 have been the most intensively studied mass stranding events and have been associated with naval maneuvers that were using sonar.

Between 1960 and 2006, 48 strandings (68 percent) involved beaked whales, 3 (4 percent) involved dolphins, and 14 (20 percent) involved other whale species. Cuvier's beaked whales were involved in the greatest number of these events (48 strandings or 68 percent), followed by sperm whales (7 strandings or 10 percent), and Blainville's and Gervais' beaked whales (4 each or 6 percent). Naval activities that might have involved active sonar are reported to have coincided with 9 (13 percent) or 10 (14 percent) of those stranding events. Between the mid-1980s and 2003 (the period reported by the IWC), we identified reports of 44 mass cetacean stranding events of which at least 7 were coincident with naval exercises that were using mid-frequency sonar. A list of stranding events that are considered to be associated with MFAS is presented in the proposed rulemaking for the Navy's training in the Hawaii Range Complex (73 FR 35510; June 23, 2008).

Association Between Mass Stranding Events and Exposure to MFAS

Several authors have noted similarities between some of these mass stranding incidents: They occurred in islands or archipelagoes with deep water nearby, several appeared to have been associated with acoustic waveguides like surface ducting, and the sound fields created by vessels transmitting mid-frequency sonar (Cox *et al.,* 2006, D'Spain *et al.,* 2006). However, only low intensity sonars and low intensity acoustic sources are proposed for the Keyport Range Complex RDT&E and range extension activities, and no powerful MFAS such as the 53C series tactical sonar would be used for these activities; therefore, their zones of influence are much smaller compared to these highest powered surface vessel sources, and animals can be more easily detected in these smaller areas, thereby increasing the probability that sonar operations can be modified to reduce the risk of injury to marine mammals. In addition, the proposed test events differ significantly from major Navy exercises and training, which involve multi-vessel training scenarios using the AN/SQS–53/56 source that have been associated with past strandings. Therefore, their zones of influence are much smaller and are less likely to affect marine mammals. Although Cuvier's beaked whales have been the most common species involved in these stranding events (81 percent of the total number of stranded animals), other beaked whales (including *Mesoplodon europeaus, M. densirostris,* and *Hyperoodon ampullatus*) comprise 14 percent of the total. Other species (*Stenella coeruleoalba, Kogia breviceps* and *Balaenoptera acutorostrata*) have stranded, but in much lower numbers and less consistently than beaked whales.

Based on the available evidence, however, we cannot determine whether (a) Cuvier's beaked whale is more prone to injury from high-intensity sound than other species, (b) their behavioral responses to sound make them more likely to strand, or (c) they are more likely to be exposed to mid-frequency active sonar than other cetaceans (for reasons that remain unknown). Because the association between active sonar (mid-frequency) exposures and marine mammal mass stranding events is not consistent—some marine mammals strand without being exposed to sonar and some sonar transmissions are not associated with marine mammal stranding events despite their co-occurrence—other risk factors or a grouping of risk factors probably contribute to these stranding events.

Behaviorally Mediated Responses to HFAS/MFAS That May Lead to Stranding

Although the confluence of Navy mid-frequency active tactical sonar with the other contributory factors noted in the report was identified as the cause of the 2000 Bahamas stranding event, the specific mechanisms that led to that stranding (or the others) are not understood, and there is uncertainty regarding the ordering of effects that led to the stranding. It is unclear whether beaked whales were directly injured by sound (acoustically mediated bubble growth, addressed above) prior to stranding or whether a behavioral response to sound occurred that ultimately caused the beaked whales to strand and be injured.

Although causal relationships between beaked whale stranding events and active sonar remain unknown, several authors have hypothesized that stranding events involving these species in the Bahamas and Canary Islands may have been triggered when the whales changed their dive behavior in a startle response to exposure to active sonar or to further avoid exposure (Cox *et al.,* 2006, Rommel *et al.,* 2006). These authors proposed three mechanisms by which the behavioral responses of beaked whales upon being exposed to active sonar might result in a stranding event. These include: Gas bubble formation caused by excessively fast surfacing; remaining at the surface too long when tissues are supersaturated with nitrogen; or diving prematurely when extended time at the surface is necessary to eliminate excess nitrogen. More specifically, beaked whales that occur in deep waters that are in close proximity to shallow waters (for example, the ''canyon areas'' that are cited in the Bahamas stranding event; see D'Spain and D'Amico, 2006), may respond to active sonar by swimming into shallow waters to avoid further exposures and strand if they were not able to swim back to deeper waters. Second, beaked whales exposed to active sonar might alter their dive behavior. Changes in their dive behavior might cause them to remain at the surface or at depth for extended periods of time, which could lead to hypoxia directly by increasing their oxygen demands or indirectly by increasing their energy expenditures (to remain at depth) and increase their oxygen demands as a result. If beaked whales are at depth when they detect a ping from an active sonar transmission and change their dive profile, this could lead to the formation of significant gas bubbles, which could damage multiple organs or interfere with normal physiological function (Cox *et al.,* 2006; Rommel *et al.,* 2006; Zimmer and Tyack, 2007). Baird *et al.* (2005) found that slow ascent rates from deep dives and long periods of time spent within 50 m of the surface were typical for both Cuvier's and Blainville's beaked whales, the two species involved in mass strandings related to naval sonar. These two behavioral mechanisms may be necessary to purge excessive dissolved nitrogen concentrated in their tissues during their frequent long dives (Baird *et al.,* 2005). Baird *et al.* (2005) further suggests that abnormally rapid ascents or premature dives in response to high intensity sonar could indirectly result in physical harm to the beaked whales, through the mechanisms described above (gas bubble formation or non-elimination of excess nitrogen).

Because many species of marine mammals make repetitive and prolonged dives to great depths, it has long been assumed that marine mammals have evolved physiological mechanisms to protect against the effects of rapid and repeated decompressions. Although several investigators have identified physiological adaptations that may protect marine mammals against nitrogen gas supersaturation (alveolar collapse and elective circulation; Kooyman *et al.,* 1972; Ridgway and Howard, 1979), Ridgway and Howard (1979) reported that bottlenose dolphins that were trained to dive repeatedly had muscle tissues that were substantially supersaturated with nitrogen gas. Houser *et al.* (2001) used these data to model the accumulation of nitrogen gas within the muscle tissue of other marine mammal species and concluded that cetaceans that dive deep and have slow ascent or descent speeds would have tissues that are more supersaturated with nitrogen gas than other marine mammals. Based on these data, Cox *et al.* (2006) hypothesized that a critical dive sequence might make beaked whales more prone to stranding in response to acoustic exposures. The sequence began with (1) very deep (to depths as deep as 2 kilometers) and long (as long as 90 minutes) foraging dives with (2) relatively slow, controlled ascents, followed by (3) a series of ''bounce'' dives between 100 and 400 m (328 and 1,323 ft) in depth (also see Zimmer and Tyack, 2007). They concluded that acoustic exposures that disrupted any part of this dive sequence (for example, causing beaked whales to spend more time at surface without the bounce dives that are necessary to recover from the deep dive) could produce excessive levels of nitrogen supersaturation in their tissues, leading to gas bubble and emboli formation that produces pathologies similar to decompression sickness.

Recently, Zimmer and Tyack (2007) modeled nitrogen tension and bubble growth in several tissue compartments for several hypothetical dive profiles and concluded that repetitive shallow dives (defined as a dive where depth does not exceed the depth of alveolar collapse, approximately 72 m (236 ft) for *Ziphius*), perhaps as a consequence of an extended avoidance reaction to sonar sound, could pose a risk for decompression sickness and that this risk should increase with the duration of the response. Their models also suggested that unrealistically more rapid ascent rates from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected. Tyack *et al.* (2006) suggested that emboli observed in animals exposed to midfrequency range sonar (Jepson *et al.,* 2003; Fernandez *et al.,* 2005) could stem from a behavioral response that involves repeated dives shallower than the depth of lung collapse. Given that nitrogen gas accumulation is a passive process (*i.e.,* nitrogen is metabolically inert), a bottlenose dolphin was trained to repetitively dive a profile predicted to elevate nitrogen saturation to the point that nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of asymptomatic nitrogen gas bubbles (Houser *et al.,* 2007).

If marine mammals respond to a Navy vessel that is transmitting active sonar in the same way that they might respond to a predator, their probability of flight responses should increase when they perceive that Navy vessels are approaching them directly, because a direct approach may convey detection and intent to capture (Burger and Gochfeld, 1981; 1990; Cooper, 1997; 1998). The probability of flight responses should also increase as received levels of active sonar increase (and the vessel is, therefore, closer) and as vessel speeds increase (that is, as approach speeds increase). For example, the probability of flight responses in Dall's sheep (*Ovis dalli dalli*) (Frid, 2001a, b), ringed seals (*Phoca hispida*) (Born *et al.,* 1999), Pacific brant (*Branta bernic nigricans*) and Canada geese (*B. canadensis*) increased as a helicopter or fixed-wing aircraft approached groups of these animals more directly (Ward *et al.,* 1999). Bald eagles (*Haliaeetus leucocephalus*) perched on trees alongside a river were also more likely to flee from a paddle raft when their perches were closer to the river or were closer to the ground (Steidl and Anthony, 1996).

Despite the many theories involving bubble formation (both as a direct cause of injury (see Acoustically Mediated Bubble Growth Section) and an indirect cause of stranding (see Behaviorally Mediated Bubble Growth Section), Southall *et al.,* (2007) summarizes that scientific disagreement or complete lack of information exists regarding the following important points: (1) Received acoustical exposure conditions for animals involved in stranding events; (2) pathological interpretation of observed lesions in stranded marine mammals; (3) acoustic exposure conditions required to induce such physical trauma directly; (4) whether noise exposure may cause behavioral reactions (such as atypical diving behavior) that secondarily cause bubble formation and tissue damage; and (5) the extent to which the post mortem artifacts introduced by decomposition before sampling, handling, freezing, or necropsy procedures affect interpretation of observed lesions.

Unlike those past stranding events that were coincident with military mid-frequency sonar use and were speculated to most likely have been caused by exposure to the sonar, those naval exercises involved multiple vessels in waters with steep bathymetry where deep channeling of sonar signals was more likely. The proposed RDT&E activities within the Keyport Range Complex Extension would not involve multi-vessel operations, would not use powerful sonar such as the AN/SQQ–53C/56 MFAS, and the bathymetry bears no similarity to where those mass strandings occurred (*e.g.,* Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); Hanalei Bay, Kaua'i, Hawaii (2004); and Spain (2006)). Consequently, because of the nature of the Keyport Range operations (which involve less powerful active sonar (MFAS/HFAS) and other sound sources, and no high-speed, multi-vessel training scenarios) and the fact that the Keyport Range Complex Extension has none of the bathymetric features that have been associated with mass strandings in the past, NMFS concludes it is unlikely that sonar use would result in a stranding event in the Keyport Range Complex region.

Estimated Take of Marine Mammals

With respect to the MMPA, NMFS's effects assessment serves four primary purposes: (1) To prescribe the permissible methods of taking (*i.e.,* Level B Harassment (behavioral harassment), Level A harassment (injury), or mortality, including an identification of the number and types of take that could occur by Level A or B harassment or mortality) and to prescribe other means of effecting the least practicable adverse impact on such species or stock and its habitat (*i.e.,* mitigation); (2) to determine whether the specified activity will have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activity will adversely affect the species or stock through effects on annual rates of recruitment or survival); (3) to determine whether the specified activity will have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (however, there are no subsistence communities that would be affected in the Keyport Range Complex Study Area, so this determination is inapplicable for this rulemaking); and (4) to prescribe requirements pertaining to monitoring and reporting.

In the Potential Impacts to Marine Mammal Species section, NMFS identifies the lethal responses, physical trauma, sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), and behavioral responses that could potentially result from exposure to active acoustic sources (*e.g.,* powerful sonar). In this section, we will relate the potential effects to marine mammals from active acoustic sources to the MMPA regulatory definitions of Level A and Level B Harassment and attempt to quantify the effects that might occur from the specific RDT&E activities that the Navy is proposing in the Keyport Range Complex.

Definition of Harassment

As mentioned previously, with respect to military readiness activities, Section 3(18)(B) of the MMPA defines ''harassment'' as: (i) Any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].

Level B Harassment

Of the potential effects that were described in the Potential Impacts to Marine Mammals Species section, the following are the types of effects that fall into the Level B Harassment category:

Behavioral Harassment—Behavioral disturbance that rises to the level described in the definition above, when resulting from exposures to active acoustic sources, is considered Level B Harassment. Some of the lower level physiological stress responses will also likely co-occur with the predicted harassments, although these responses are more difficult to detect and fewer data exist relating these responses to specific received levels of sound. When Level B Harassment is predicted based on estimated behavioral responses, those takes may have a stress-related physiological component as well.

In the effects section above, we described the Southall *et al.,* (2007) severity scaling system and listed some examples of the three broad categories of behaviors: (0–3: Minor and/or brief behaviors); 4–6 (Behaviors with higher potential to affect foraging, reproduction, or survival); 7–9 (Behaviors considered likely to affect the aforementioned vital rates). Generally speaking, MMPA Level B Harassment, as defined in this document, would include the behaviors described in the 7–9 category, and a subset, dependent on context and other considerations, of the behaviors described in the 4–6 categories. Behavioral harassment generally does not include behaviors ranked 0–3 in Southall *et al.,* (2007).

Acoustic Masking and Communication Impairment—Acoustic masking is considered Level B Harassment, as it can disrupt natural behavioral patterns by interrupting or limiting the marine mammal's receipt or transmittal of important information or environmental cues.

TTS—As discussed previously, TTS can affect how an animal behaves in response to the environment, including conspecifics, predators, and prey. The following physiological mechanisms are thought to play a role in inducing auditory fatigue: Effects to sensory hair cells in the inner ear that reduce their sensitivity, modification of the chemical environment within the sensory cells, residual muscular activity in the middle ear, displacement of certain inner ear membranes, increased blood flow, and post-stimulatory reduction in both efferent and sensory neural output. Ward (1997) suggested that when these effects result in TTS rather than PTS, they are within the normal bounds of physiological variability and tolerance and do not represent a physical injury. Additionally, Southall *et al.* (2007) indicate that although PTS is a tissue injury, TTS is not because the reduced hearing sensitivity following exposure to intense sound results primarily from fatigue, not loss, of cochlear hair cells and supporting structures and is reversible. Accordingly, NMFS classifies TTS (when resulting from exposure to active acoustic sources) as Level B Harassment, not Level A Harassment (injury).

Level A Harassment

Of the potential effects that were described in the Potential Impacts to Marine Mammal Species section, following are the types of effects that fall into the Level A Harassment category:

PTS—PTS (resulting either from exposure to active acoustic sources) is irreversible and considered an injury. PTS results from exposure to intense sounds that cause a permanent loss of inner or outer cochlear hair cells or exceed the elastic limits of certain tissues and membranes in the middle and inner ears and results in changes in the chemical composition of the inner ear fluids.

Acoustically Mediated Bubble Growth—A few theories suggest ways in which gas bubbles become enlarged through exposure to intense sounds (HFAS/MFAS) to the point where tissue damage results. In rectified diffusion, exposure to a sound field would cause bubbles to increase in size. Alternately, bubbles could be destabilized by high level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. Tissue damage from either of these processes would be considered an injury.

Behaviorally Mediated Bubble Growth—Several authors suggest mechanisms in which marine mammals could behaviorally respond to exposure to HFAS/MFAS by altering their dive patterns in a manner (unusually rapid ascent, unusually long series of surface dives, etc.) that might result in unusual bubble formation or growth ultimately resulting in tissue damage (emboli, etc.).

Acoustic Take Criteria for Naval Sonar

For the purposes of an MMPA incidental take authorization, three types of take are identified: Level B harassment; Level A harassment; and mortality (or serious injury leading to mortality). The categories of marine mammal responses (physiological and behavioral) that fall into the two harassment categories were described in the previous section.

Because the physiological and behavioral responses of the majority of the marine mammals exposed to HFAS/

MFAS cannot be detected or measured, a method is needed to estimate the number of individuals that will be taken, pursuant to the MMPA, based on the proposed action. To this end, NMFS uses acoustic criteria that estimate the received level (when exposed to HFAS/MFAS) at which Level B or Level A harassment would occur. The acoustic criteria for HFAS/MFAS are discussed below.

Because relatively few applicable data exist to support acoustic criteria specifically for HFAS, and it is suspected that the majority of the adverse effects are from the MFAS due to their larger impact ranges, NMFS will apply the criteria developed for the MFAS to the HFAS as well.

NMFS utilizes three acoustic criteria for HFAS/MFAS: PTS (injury—Level A Harassment), behavioral harassment from TTS, and sub-TTS (Level B Harassment). Because the TTS and PTS criteria are derived similarly and the PTS criteria was extrapolated from the TTS data, the TTS and PTS acoustic criteria will be presented first, before the behavioral criteria. For more information regarding these criteria, please see the Navy's LOA application for the Keyport Range Complex RDT&E and range extension activities.

Level B Harassment Threshold (TTS)

As mentioned above, behavioral disturbance, acoustic masking, and TTS are all considered Level B Harassment. Marine mammals would usually be behaviorally disturbed at lower received levels than those at which they would likely sustain TTS, so the levels at which behavioral disturbance is likely to occur are considered the onset of Level B Harassment. The behavioral responses of marine mammals to sound are variable, context specific, and, therefore, difficult to quantify (see Risk Function section, below). TTS is a physiological effect that has been studied and quantified in laboratory conditions. NMFS also uses an acoustic criteria to estimate the number of marine mammals that might sustain TTS incidental to a specific activity (in addition to the behavioral criteria).

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. The existing cetacean TTS data are summarized in the following bullets.

- Schlundt *et al.* (2000) reported the results of TTS experiments conducted with 5 bottlenose dolphins and 2 belugas exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway *et al.* (1997). At frequencies of 3, 10, and 20 kHz, sound pressure levels (SPLs) necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 microPa (EL = 192 to 201 dB re 1 microPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 microPa and 195 dB re 1 microPa^2-s, respectively.
- Finneran *et al.* (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 microPa^2-s. These results were consistent with the data of Schlundt *et al.* (2000) and showed that the Schlundt *et al.* (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.
- Nachtigall *et al.* (2003) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall *et al.* (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 microPa (EL about 213 dB re microPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 microPa. Nachtigall *et al.* (2004) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 microPa (EL about 193 to 195 dB re 1 microPa^2-s). The difference in results was attributed to faster post exposure threshold measurement—TTS may have recovered before being detected by Nachtigall *et al.* (2003). These studies showed that, for long duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones.
- Finneran *et al.* (2000, 2002) conducted TTS experiments with dolphins and belugas exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic waterguns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.
- Mooney *et al.* (2009) exposed a bottlenose dolphin with a ''typical'' mid-frequency naval sonar signal (two down sweeps of 0.5 s each separated by a 0.5 s gap, fundamental frequency approximately 3–4 kHz with multiple harmonics) recorded within the Puget Sound, Washington. Successive three-ping blocks, each block spaced 24 s apart, were used to simulate a ''typical'' mid-frequency sonar application. To evaluate TTS, hearing thresholds for a 5.6 kHz tone were measured before and after noise exposure using the physiological method of auditory evoked potentials. Sonar SPLs were gradually increased up to 203 dB SPL (rms) (measured at the location of the dolphin's ear) for individual pings. The ping number was then increased over multiple exposure sessions until a threshold shift was induced. Results showed that only the five blocks of sonar pings, presenting an SPL of 203 dB (SEL of 214 dB re 1 microPa^2-s), reliably induced shifts for three consecutive research sessions.
- Kastak *et al.* (1999a, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal and a Pacific harbor seal, exposed to continuous underwater sounds at levels of 80 and 95 dB sensation level (the level above its hearing threshold) at 2.5 and 3.5 kHz for up to 50 minutes. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Some of the more important data obtained from these studies are onset-TTS levels (exposure levels sufficient to cause a just-measurable amount of TTS) often defined as 6 dB of TTS (for example, Schlundt *et al.,* 2000) and the fact that energy metrics (sound exposure levels (SEL), which include a duration component) better predict when an animal will sustain TTS than pressure (SPL) alone. NMFS' TTS criteria (which indicate the received level at which onset TTS (<6dB) is induced, expressed in SELs) for HFAS/MFAS are as follows:

- Cetaceans—195 dB re 1 microPa^2-s (based on mid-frequency cetaceans—no published data exist on auditory effects of noise in low or high frequency cetaceans (Southall *et al.,* 2007)).
- Pinnipeds:
  - —Harbor Seals (and closely related species)—183 dB re 1 microPa^2-s
  - —Northern Elephant Seals (and closely related species)—204 dB re 1 microPa^2-s
  - —California Sea Lions (and closely related species)—206 dB re 1 microPa^2-s

A detailed description of how TTS criteria were derived from the results of the above studies may be found in Chapter 3 of Southall *et al.* (2007), as well as the Navy's Keyport Range Complex LOA application.

Level A Harassment Threshold (PTS)

For acoustic effects, because the tissues of the ear appear to be the most susceptible to the physiological effects of sound, and because threshold shifts tend to occur at lower exposures than other more serious auditory effects, NMFS has determined that PTS is the best indicator for the smallest degree of injury that can be measured. Therefore, the acoustic exposure associated with onset-PTS is used to define the lower limit of the Level A harassment.

PTS data do not currently exist for marine mammals and are unlikely to be obtained due to ethical concerns. However, PTS levels for these animals may be estimated using TTS data from marine mammals and relationships between TTS and PTS that have been discovered through study of terrestrial mammals. NMFS uses the following acoustic criteria for injury (expressed in SELs):

- Cetaceans—215 dB re 1 microPa^2-s (based on mid-frequency cetaceans—no published data exist on auditory effects of noise in low or high frequency cetaceans (Southall *et al.,* 2007)).
- Pinnipeds:

—Harbor Seals (and closely related species)—203 dB re 1 microPa^2-s
—Northern Elephant Seals (and closely related species)—224 dB re 1 microPa^2-s
—California Sea Lions (and closely related species)—226 dB re 1 microPa^2-s

These criteria are based on a 20 dB increase in SEL over that required for onset-TTS. Extrapolations from terrestrial mammal data indicate that PTS occurs at 40 dB or more of TS, and that TS growth occurs at a rate of approximately 1.6 dB TS per dB increase in EL. There is a 34-dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). Therefore, an animal would require approximately 20-dB of additional exposure (34 dB divided by 1.6 dB) above onset-TTS to reach PTS. A detailed description of how TTS criteria were derived from the results of the above studies may be found in Chapter 3 of Southall *et al.* (2007), as well as the Navy's Keyport Range Complex LOA application. Southall *et al.* (2007) recommend a precautionary dual criteria for TTS (230 dB re 1 microPa (SPL) in addition to 215 re 1 microPa^2-s (SEL)) to account for the potentially damaging transients embedded within non-pulse exposures. However, in the case of HFAS/MFAS, the distance at which an animal would receive 215 (SEL) is farther from the source than the distance at which they would receive 230 (SPL) and therefore, it is not necessary to consider 230 dB.

We note here that behaviorally mediated injuries (such as those that have been hypothesized as the cause of some beaked whale strandings) could potentially occur in response to received levels lower than those believed to directly result in tissue damage. As mentioned previously, data to support a quantitative estimate of these potential effects (for which the exact mechanism is not known and in which factors other than received level may play a significant role) do not exist.

Level B Harassment Risk Function (Behavioral Harassment)

The first MMPA authorization for take of marine mammals incidental to tactical active sonar was issued in 2006 for Navy Rim of the Pacific training exercises in Hawaii. For that authorization, NMFS used 173 dB SEL as the criterion for the onset of behavioral harassment (Level B Harassment). This type of single number criterion is referred to as a step function, in which (in this example) all animals estimated to be exposed to received levels above 173 dB SEL would be predicted to be taken by Level B Harassment and all animals exposed to less than 173 dB SEL would not be taken by Level B Harassment. As mentioned previously, marine mammal behavioral responses to sound are highly variable and context specific (affected by differences in acoustic conditions; differences between species and populations; differences in gender, age, reproductive status, or social behavior; or the prior experience of the individuals), which does not support the use of a step function to estimate behavioral harassment.

Unlike step functions, acoustic risk continuum functions (which are also called ''exposure-response functions,'' ''dose-response functions,'' or ''stress response functions'' in other risk assessment contexts) allow for probability of a response that NMFS would classify as harassment to occur over a range of possible received levels (instead of one number) and assume that the probability of a response depends first on the ''dose'' (in this case, the received level of sound) and that the probability of a response increases as the ''dose'' increases. The Navy and NMFS have previously used acoustic risk functions to estimate the probable responses of marine mammals to acoustic exposures in the Navy FEISs on SURTASS LFA sonar (DoN, 2001c) and the North Pacific Acoustic Laboratory experiments conducted off the Island of Kauai (ONR, 2001). The specific risk functions used here were also used in the MMPA regulations and FEIS for Hawaii Range Complex (HRC), Southern California Range Complex (SOCAL), Atlantic Fleet Active Sonar Testing (AFAST), and the Naval Surface Warfare Center Panama City Division (NSWC PCD) mission activities. As discussed in the Effects section, factors other than received level (such as distance from or bearing to the sound source) can affect the way that marine mammals respond; however, data to support a quantitative analysis of those (and other factors) do not currently exist. NMFS will continue to modify these criteria as new data become available.

The methodology described below is based on surface ship acoustic sources. The NAVSEA NUWC Keyport Range does not utilize these sources in RDT&E activities. It should be noted though, that the sources methodology described below is utilized for the modeling of potential exposures to mid- and high-frequency active sonar.

To assess the potential effects on marine mammals associated with active sonar used during training activity the Navy and NMFS applied a risk function that estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) as defined in the SURTASS LFA Sonar Final OEIS/EIS (DoN, 2001), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN, 2007a), for the probability of MFA sonar risk for Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes and odontocetes (NMFS, 2008). The same risk function and input parameters will be applied to high frequency active (HFA) (<10 kHz) sources until applicable data become available for high frequency sources.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in U.S. Department of the Navy (2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1-\left(\frac{L-B}{K}\right)^{-A}}{1-\left(\frac{L-B}{K}\right)^{-2A}}$$

Where:

R = Risk (0–1.0)
L = Received level (dB re: 1 μPa)
B = Basement received level = 120 dB re: 1 μPa
K = Received level increment above B where 50 percent risk = 45 dB re: 1 μPa
A = Risk transition sharpness parameter = 10 (odontocetes) or 8 (mysticetes)

In order to use this function to estimate the percentage of an exposed population that would respond in a manner that NMFS classifies as Level B harassment, based on a given received level, the values for B, K and A need to be identified.

B Parameter (Basement)—The B parameter is the estimated received level below which the probability of disruption of natural behavioral patterns, such as migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered approaches zero for the HFAS/MFAS risk assessment. At this received level, the curve would predict that the percentage of the exposed population that would be taken by Level B Harassment approaches zero. For HFAS/MFAS, NMFS has determined that B = 120 dB re 1 μPa (SPL). This level is based on a broad overview of the levels at which many species have been reported responding to a variety of sound sources.

K Parameter (Representing the 50-Percent Risk Point)—The K parameter is based on the received level that corresponds to 50 percent risk, or the received level at which we believe 50 percent of the animals exposed to the designated received level will respond in a manner that NMFS classifies as Level B Harassment. The K parameter (K = 45 dB) is based on three datasets in which marine mammals exposed to mid-frequency sound sources were reported to respond in a manner that NMFS would classify as Level B Harassment. There is widespread consensus that marine mammal responses to HFA/MFA sound signals need to be better defined using controlled exposure experiments (Cox *et al.,* 2006; Southall *et al.,* 2007). The Navy is contributing to an ongoing behavioral response study in the Bahamas that is expected to provide some initial information on beaked whales, the species identified as the most sensitive to MFAS. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures. Until additional data are available, however, NMFS and the Navy have determined that the following three data sets are most applicable for direct use in establishing the K parameter for the HFAS/MFAS risk function. These data sets, summarized below, represent the only known data that specifically relate altered behavioral responses (that NMFS would consider Level B Harassment) to exposure to HFAS/MFAS sources.

Even though these data are considered the most representative of the proposed specified activities, and therefore the most appropriate on which to base the K parameter (which basically determines the midpoint) of the risk function, these data have limitations, which are discussed in Appendix C of the NAVSEA NUWC Keyport Range Complex Extension EIS/OEIS.

1. Controlled Laboratory Experiments with Odontocetes (SSC Dataset)—Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran *et al.,* 2001, 2003, 2005; Finneran and Schlundt, 2004; Schlundt *et al.,* 2000). In experimental trials (designed to measure TTS) with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus, but also included attempts to avoid an exposure in progress, aggressive behavior, or refusal to further participate in tests.

Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt *et al.* (2000) and Finneran *et al.* (2001, 2003, 2005) experiments. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1microPa) conducted by Schlundt *et al.* (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

• Schlundt *et al.* (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones and exposure frequencies of 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. Schlundt *et al.* (2000) reported eight individual TTS experiments. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt *et al.* (2000) reported that ''behavioral alterations,'' or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

• Finneran *et al.* (2001, 2003, 2005) conducted two separate TTS experiments using 1-sec tones at 3 kHz. The test methods were similar to that of Schlundt *et al.* (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 microPa^2/Hz), and no masking noise was used. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB SPL were randomly presented.

Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 microPa (rms), and beluga whales did so at received levels of 180 to 196 dB and above.

2. Mysticete Field Study (Nowacek *et al.,* 2004)—The only available and applicable data relating mysticete responses to exposure to mid-frequency sound sources are from Nowacek *et al.* (2004). Nowacek *et al.* (2004) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components in the Bay of Fundy. Investigators used archival digital acoustic recording tags (DTAG) to record the behavior (by measuring pitch, roll, heading, and depth) of right whales in the presence of an alert signal, and to calibrate received sound levels. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) Alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1 sec long. The purposes of the

alert signal were (a) to pique the mammalian auditory system with disharmonic signals that cover the whales' estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and (c) to provide localization cues for the whale. The maximum source level used was 173 dB SPL.

Nowacek *et al.* (2004) reported that five out of six whales exposed to the alert signal with maximum received levels ranging from 133 to 148 dB re 1 microPa significantly altered their regular behavior and did so in identical fashion. Each of these five whales: (i) Abandoned their current foraging dive prematurely as evidenced by curtailing their 'bottom time'; (ii) executed a shallow-angled, high power (*i.e.*, significantly increased fluke stroke rate) ascent; (iii) remained at or near the surface for the duration of the exposure, an abnormally long surface interval; and (iv) spent significantly more time at subsurface depths (1–10 m) compared with normal surfacing periods, when whales normally stay within 1 m (1.1 yd) of the surface.

3. Odontocete Field Data (Haro Strait—USS SHOUP)—In May 2003, killer whales were observed exhibiting behavioral responses generally described as avoidance behavior while the U.S. Ship (USS) SHOUP was engaged in MFAS in the Haro Strait in the vicinity of Puget Sound, Washington. Those observations have been documented in three reports developed by Navy and NMFS (NMFS, 2005a; Fromm, 2004a, 2004b; DON, 2003). Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the sonar operations was estimated using standard acoustic propagation models that were verified (for some but not all signals) based on calibrated in situ measurements from an independent researcher who recorded the sounds during the event. Behavioral observations were reported for the group of whales during the event by an experienced marine mammal biologist who happened to be on the water studying them at the time. The observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, non-captive animals upon actual exposure to AN/SQS–53 sonar.

U.S. Department of Commerce (NMFS, 2005a); U.S. Department of the Navy (2004b); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of received level (which ranged from 150 to 180 dB) at an approximate whale location with a mean value of 169.3 dB SPL.

Calculation of K Parameter—NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) The mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek *et al.* (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

A Parameter (Steepness)—NMFS determined that a steepness parameter (A)=10 is appropriate for odontocetes (except harbor porpoises) and pinnipeds and A=8 is appropriate for mysticetes.

The use of a steepness parameter of A=10 for odontocetes (except harbor porpoises) for the HFAS/MFAS risk function was based on the use of the same value for the SURTASS LFA risk continuum, which was supported by a sensitivity analysis of the parameter presented in Appendix D of the SURTASS/LFA FEIS (DoN, 2001c). As concluded in the SURTASS FEIS/EIS, the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme *et al.,* 1984; Buck and Tyack, 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D, and NMFS, 2008).

NMFS determined that a lower steepness parameter (A=8), resulting in a shallower curve, was appropriate for use with mysticetes and HFAS/MFAS. The Nowacek *et al.* (2004) dataset contains the only data illustrating mysticete behavioral responses to a mid-frequency sound source. A shallower curve (achieved by using A=8) better reflects the risk of behavioral response at the relatively low received levels at which behavioral responses of right whales were reported in the Nowacek *et al.* (2004) data. Compared to the odontocete curve, this adjustment results in an increase in the proportion of the exposed population of mysticetes being classified as behaviorally harassed at lower RLs, such as those reported here and is supported by the only dataset currently available.

Basic Application of the Risk Function—The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and research activities with HFA/MFA sonar) at a given received level of sound. For example, at 165 dB SPL (dB re 1 Pa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data primarily used to produce the risk function (the K parameter) were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience, the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall *et al.,* 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available (Figure 1).

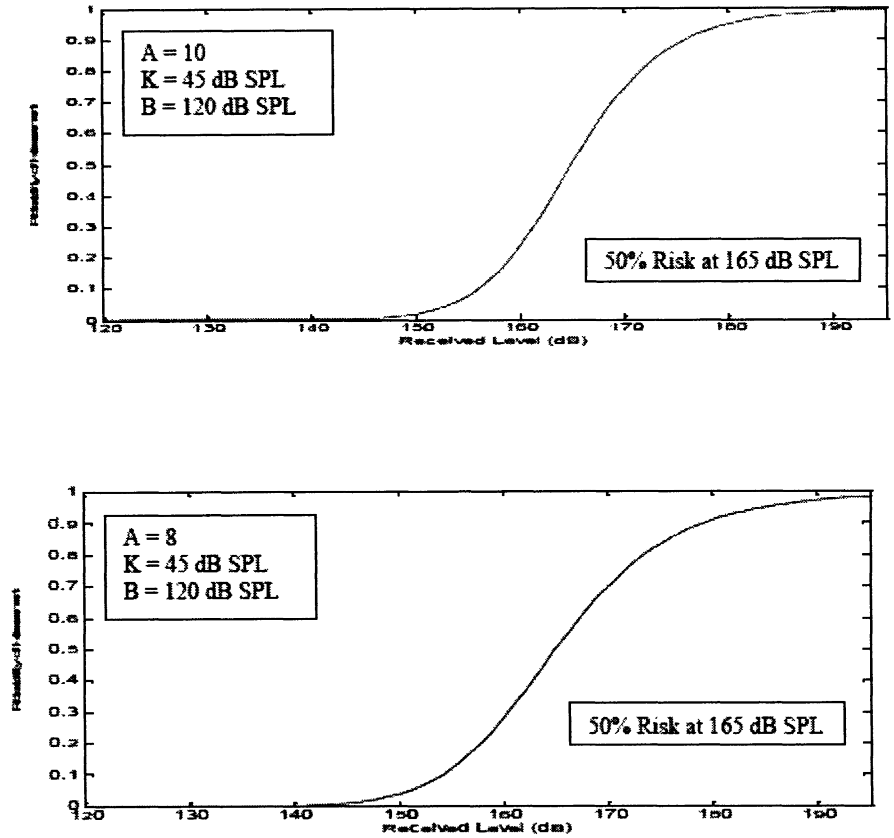

Figure 1. Risk Functions for Odontocetes (above) and Mysticetes (below).

As more specific and applicable data become available for HFAS/MFAS sources, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic. Ultimately, data may exist to justify the use of additional, alternate, or multivariate functions. For example, as mentioned previously, the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok *et al.,* 2003).

Specific Consideration for Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (*e.g.,* Kastelein *et al.,* 2000; 2005a; 2006) and wild harbor porpoises (*e.g.,* Johnston, 2002) responded to sound (*e.g.,* acoustic harassment devices (ADHs), acoustic deterrent devices (ADDs), or other non-pulsed sound sources) is very low (*e.g.,* ~120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, the risk function curve as presented is not used. Instead, a step function threshold of 120 dB SPL is used to estimate take of harbor porpoises (*i.e.,* assumes that all harbor porpoises exposed to 120 dB or higher MFAS/HFAS will respond in a way NMFS considers behavioral harassment).

Modeling Acoustic Effects

The methodology for analyzing potential impacts from mid- and high-frequency acoustic sources is presented in this section, which defines the model process in detail, describes how the impact threshold derived from Navy-NMFS consultations are derived, and discusses relative potential impact based on species biology.

Modeling methods applied herein were originally developed for mid-frequency (1–10 kHz) active (MFA) sonars (*e.g.,* surface-ship hull-mounted sonars, which are not used in the NAVSEA NUWC Keyport Range Complex). Nevertheless, the methods and thresholds are agreed upon by the U.S. Navy and NMFS as the best available science with which to determine the extent of physiological or behavioral effects on marine mammals that would result from the use of mid-frequency active (MFA) and high frequency active (HFA) acoustic sources for this proposed action. Detailed descriptions of the modeling process and results are provided in LOA Application.

The Navy acoustic exposure model process uses a number of inter-related software tools to assess potential exposure of marine mammals to Navy generated underwater sound. For sonar, these tools estimate potential impact volumes and areas over a range of thresholds for sonar specific operating modes. Results are based upon extensive pre-computations over the range of acoustic environments that might be encountered in the operating area.

The process includes four steps used to calculate potential exposures:

• Identify unique acoustic environments that encompass the operating area. Parameters include depth and seafloor geography, bottom characteristics and sediment type, wind and surface roughness, sound velocity profile, surface duct, sound channel, and convergence zones.

• Compute transmission loss (TL) data appropriate for each sensor type in each of these acoustic environments.

Propagation can be complex depending on a number of environmental parameters listed in step one, as well as sonar operating parameters such as directivity, source level, ping rate, and ping length. The Navy standard CASS–GRAB acoustic propagation model is used to resolve these complexities for underwater propagation prediction.

- Use that TL to estimate the total sound energy received at each point in the acoustic environment.
- Apply this energy to predicted animal density for that area to estimate potential acoustic exposure, with animals distributed in 3–D based on best available science on animal dive profiles.

The primary potential impact to marine mammals from underwater acoustics is Level B harassment from noise. A certain proportion of marine mammals are expected to experience behavioral disturbance at different received sound pressure levels and are counted as Level B harassment exposures. A detailed discussion of the modeling is provided in the Navy's LOA application.

Step 1. Acoustic Sources

For modeling purposes, acoustic source parameters were based on records from previous RDT&E activities, to reflect the underwater sound use expected to occur during activities in the NAVSEA NUWC Keyport Range Complex. The actual acoustic source parameters in many cases are classified, however, modeling used to calculate exposures to marine mammals employed actual and preferred parameters which have in the past been used during RDT&E activities in the NAVSEA NUWC Keyport Range Complex.

Every use of underwater acoustic energy includes the potential to harass marine animals in the vicinity of the source. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the manner in which the acoustic source is operated (*i.e.,* source level, depth, frequency, pulse length, directivity, platform speed, repetition rate). A wide variety of systems/equipment that utilize narrowband acoustic sources are employed at the NAVSEA NUWC Keyport Range Complex. Eight have been selected as representative of the types of operating in this range and are described in Table 8. Take estimates for these sources are calculated and reported on a per-run basis.

TABLE 8—MID- AND HIGH-FREQUENCY ACOUSTIC SOURCES EMPLOYED IN THE KEYPORT RANGE COMPLEX

Source designation	Acoustic source description	Frequency class	Takes reported
S1	Sub-bottom profiler	Mid-frequency	Per 4-hour run.
S2	UUV source	High-frequency	Per 2-hour run.
S3	REMUS Modem	Mid-frequency	Per 2-hour run.
S4	REMUS–SAS–HF	High-frequency	Per 2-hour run.
S5	Range Target	Mid-frequency	Per 20-minute run.
S6	Test Vehicle 1	High-frequency	Per 10-minute run.
S7	Test Vehicle 2	High-frequency	Per 10-minute run.
S8	Test Vehicle 3	High-frequency	Per 10-minute run.

The acoustic modeling that is necessary to support the take estimates for each of these sources relies upon a generalized description of the manner of the operating modes. This description includes the following:

- ''Effective'' energy source level—The total energy across the band of the source, scaled by the pulse length (10 log10 [pulse length]).
- Source depth—Depth of the source in meters. Each source was modeled in the middle of the water column.
- Nominal frequency—Typically the center band of the source emission. These are frequencies that have been reported in open literature and are used to avoid classification issues. Differences between these nominal values and actual source frequencies are small enough to be of little consequence to the output impact volumes.
- Source directivity—The source beam is modeled as the product of a horizontal beam pattern and a vertical beam pattern. Two parameters define the horizontal beam pattern:
- Horizontal beam width—Width of the source beam (degrees) in the horizontal plane (assumed constant for all horizontal steer directions).
- Horizontal steer direction—Direction in the horizontal in which the beam is steered relative to the direction in which the platform is heading.

The horizontal beam has constant response across the width of the beam and with flat, 20-dB down sidelobes. (Note that steer directions φ, −φ, 180o − φ, and 180o + φ all produce equal impact volumes.)

Similarly, two parameters define the vertical beam pattern:

- Vertical beam width—Width of the source beam (degrees) in the vertical plane measured at the 3-dB down point. (The width is that of the beam steered towards broadside and not the width of the beam at the specified vertical steer direction.)
- Vertical steer direction—Direction in the vertical plane that the beam is steered relative to the horizontal (upward looking angles are positive).

To avoid sharp transitions that a rectangular beam might introduce, the power response at vertical angle θ is

$$\max\left\{\frac{\sin 2\lfloor n(\theta_s-\theta)\rfloor}{\left[n\sin(\theta_s-\theta)\right]^2}, 0.01\right\}$$

where n = 180°/θ_w is the number of half-wavelength-spaced elements in a line array that produces a main lobe with a beam width of θ_w. θ_s is the vertical beam steer direction.

Ping spacing—Distance between pings. For most sources this is generally just the product of the speed of advance of the platform and the repetition rate of the source. Animal motion is generally of no consequence as long as the source motion is greater than the speed of the animal (nominally, three knots). For stationary (or nearly stationary) sources, the ''average'' speed of the animal is used in place of the platform speed. The attendant assumption is that the animals are all moving in the same constant direction.

These parameters are defined for each of the acoustic sources in the following Table 9.

TABLE 9—DESCRIPTION OF NAVSEA NUWC KEYPORT RANGE COMPLEX SOURCES

Acoustic source description	Center frequency	Source level	Emission spacing	Vertical directivity horizontal	Horizontal directivity horizontal
Sub-bottom profiler	4.5 kHz	207 dB	0.2 m	20 deg	20 deg.
UUV source	15 kHz	205 dB	1.9 m	30 deg	50 deg.
REMUS Modem	10 kHz	186 dB	45 m	60 deg	360 deg.
REMUS–SAS–HF	150 kHz	220 dB	1.9 m	9 deg	15 deg.
Range Target	5 kHz	233 dB	93 m	60 deg	360 deg.
Test Vehicle 1	20 kHz	233 dB	45 m	20 deg	60 deg.
Test Vehicle 2	25 kHz	230 dB	540 m	20 deg	60 deg.
Test Vehicle 3	30 kHz	233 dB	617 m	20 deg	60 deg.

Step 2. Environmental Provinces

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. Propagation loss as a function of range responds to a number of environmental parameters:

- Water depth
- Sound speed variability throughout the water column
- Bottom geo-acoustic properties, and
- Wind speed

Due to the importance that propagation loss plays in modeling effects, the Navy has over the last four to five decades invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases of these environmental parameters, most of which are accepted as standards for all Navy modeling efforts.

- Water depth—Digital Bathymetry Data Base Variable Resolution (DBDBV)
- Sound speed—Generalized Digital Environmental Model (GDEM)
- Bottom loss—Low-Frequency Bottom Loss (LFBL), Sediment Thickness Database, and High-Frequency Bottom Loss (HFBL), and
- Wind speed—U.S. Navy Marine Climatic Atlas of the World

Representative environmental parameters are selected for each of the three operating areas: DBRC, Keyport, and Quinault. Sources of local environmental-acoustic properties were supplemented with Navy Standard OAML data to determine model inputs for bathymetry, sound-speed, and sediment properties.

The DBRC and Keyport ranges are located inland with limited water-depth variability: The maximum water depth in Dabob Bay is approximately 200 meters; the maximum in the Keyport range is approximately 30 meters (98 feet). The Quinault range, on the other hand, is located seaward of the Washington State Coast to depths greater than a kilometer.

Sound speed profiles for winter and summer from the OAML open-ocean database are presented in Figure 6–10 of the Navy's LOA application. The winter profile is a classic half-channel (sound speed monotonically increasing with depth). The summer profile consists of a shallow surface duct over a modest thermocline. Individual profiles taken from World Ocean Data Base (NODC, 2005) for DBRC and Keyport are generally consistent with these open-ocean profiles. Some of these profiles exhibit some effects of additional fresh water near the surface; others have a little warmer surface layer than this summer profile. However, the truncated deep-water profiles are adequately representative of the inland ranges.

The bottom type in the Quinault range varies consistently with water depth. The shallower depths (less than 500 meters) tend to have sandy bottoms (HFBL class = 2); the deeper depths tend to be silt (HFBL class = 8).

The sediment type of the DBRC and Keyport areas that we used for our modeling were different from those found in the Low Frequency Bottom Loss (LFBL) database or implied by the High-Frequency Bottom Loss (HFBL) database. Although the water depth of these areas can be greater that 50 m, the LFBL database assigned them the default ''coarse sand'' sediment type that was assigned to areas with water depth less than 50 m (Vidmar, 1994). Core data from these areas were collected as part of environmental monitoring (Llanso, 1998). Cores 14 and 15 from the northern parts of the DBRC area indicated sediments with sands and silty sands. A silty sand sediment type was assigned to these areas (HFBL class = 2). Core 304R from the southern part of the DBRC area indicated sediments with clay. A clay-silt sediment type (HFBL class = 4) was assigned to this area taking into account the transition from the more sandy northern area to the clay of the southern area. These assignments are consistent with the observation (Helton, 1976) that the boundary area between the northern and southern areas had sediments that were mostly mud with a small amount of sand. The Keyport area did not have any cores in the study area but had three cores surrounding the area: Core 308R to the northwest indicated sand sediment; core 69 to the northeast indicated sand and silty sand sediments; and core 34 to the south indicated clay sediment. Given the surrounding cores we assigned a sand-silt-clay sediment type to this area (HFBL class = 4).

The Keyport range has a proposed extension to the east and south of the existing boundaries. In addition to the existing DBRC boundary, there is one extension to the south and another extension to the south and the north. The Quinault range is extended into a much larger deep-water region coincident with W–237A with a surf zone at Pacific Beach.

Step 3. Impact Volumes and Impact Ranges

Many naval actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. Given fixed harassment metrics and thresholds, the number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

The expected impact volume associated with a particular activity is defined as the expected volume of water in which some acoustic metric exceeds a specified threshold. The product of this volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. There are two acoustic metrics for mid- and high-frequency acoustic sources effects: An energy term (energy flux density) or a pressure term (peak pressure). The thresholds associated with each of these metrics define the levels at which the animals exposed will experience some degree of harassment (ranging from behavioral change to hearing loss).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range is defined as the maximum range at which a particular threshold is exceeded for a single source emission.

The two measures of potential harm to marine wildlife due to mid- and high-frequency acoustic sources operations are the accumulated (summed over all source emissions) energy flux density received by the animal over the duration of the activity, and the peak pressure (loudest sound received) by the animal over the duration of the activity.

Regardless of the type of source, estimating the number of animals that may be harassed in a particular environment entails the following steps.

- Each source emission is modeled according to the particular operating mode of that source. The ''effective'' energy source level is computed by integrating over the bandwidth of the source, and scaling by the pulse length. The location of the source at the time of each emission must also be specified.
- For the relevant environmental acoustic parameters, Transmission Loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal center frequency of the source.
- The accumulated energy and maximum sound pressure level (SPL) are sampled over a volumetric grid within the waters surrounding a source action. At each grid point, the received signal from each source emission is modeled as the source level reduced by the appropriate propagation loss from the location of the source at the time of each emission to that grid point. The maximum SPL field is calculated by taking the maximum level of the received signal over all emissions, and the energy field is calculated by summing the energy of the signal over all emissions, and adjusting for pulse length.
- The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point for which the appropriate metric exceeds that threshold. For maximum SPL, calculation of the expected volume represented by each grid point depends on the maximum SPL at that point, and requires an extra step to apply the risk function.

Finally, the number of takes is estimated as the product (scalar or vector, depending upon whether an animal density depth distribution is available) of the impact volume and the animal densities.

(4) Computing Impact Volumes for Active Sonars

The computation for impact volumes of active acoustic sources uses the following steps:

- Identification of the underwater propagation model used to compute transmission loss data, a listing of the source-related inputs to that model, and a description of the output parameters that are passed to the energy accumulation algorithm.
- Definitions of the parameters describing each acoustic source type.
- Description of the algorithms and sampling rates associated with the energy accumulation algorithm.

A detailed discussion of computing methodologies is provided in the Navy's LOA application.

Estimated Takes of Marine Mammals

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data used in the model, and that the model results must be interpreted within the context of a given species' ecology. When reviewing the acoustic effects modeling results, it is also important to understand there have been no confirmed acoustic effects on any marine species in previous NAVSEA NUWC Keyport Range Complex exercises or from any other mid- and high-frequency active sonar RDT&E activities within the NAVSEA NUWC Keyport Range Complex.

The annual estimated number of exposures from acoustic sources are given for each species. The modeled exposure is the probability of a response that NMFS would classify as harassment under the MMPA. These exposures are calculated for all activities modeled and represent the total exposures per year and are not based on a per day basis.

Range Operating Policies and Procedures (ROP) Description operating policies and procedures, as described in NUWC Keyport Report 1509, *Range Operating Policies and Procedures Manual (ROP),* are followed for all NUWC Keyport range activities. NUWC Keyport would continue to implement the ROP policies and procedures within the NAVSEA NUWC Keyport Range Complex with implementation of the proposed range extension. The ROP is followed to protect the health and safety of the public and Navy personnel and equipment as well as to protect the marine environment. The policies and procedures address issues such as safety, development of approved run plans, range operation personnel responsibility, deficiency reporting, all facets of range activities, and the establishment of ''exclusion zones'' to ensure that there are no marine mammals within a prescribed area prior to the commencement of each in-water exercise within the NAVSEA NUWC Keyport Range Complex. All range operators are trained by NOAA in marine mammal identification, and active acoustic activities are suspended or delayed if whales, dolphins, or porpoises (cetaceans) are observed within range areas.

The modeling for acoustic sources using the risk function methodology predicts 15,130 annual acoustic exposures that result in Level B harassment and 2,026 annual exposures of pinnipeds that exceed the TTS threshold for Level B Harassment under these criteria. The model predicts 0 annual exposures that exceed the PTS threshold (Level A Harassment). The Navy is not requesting Level A harassment authorization for any marine mammal. The summary of modeled mid- and high-frequency acoustic source exposure harassment numbers by species are presented in Tables 9 through 12 and represent potential harassment after implementation of the ROP. Implementation of the ROP would result in a zero take with respect to all cetaceans except for the harbor porpoise.

Table 9. Estimated Annual MMPA Level B Exposures for Inland Water - Keyport Range Site

	TTS (Level B) Exposures	Risk Function Sub-TTS Behavioral Exposures
Harbor Seal	41	109
Total Level B Exposures (by criteria method)	41	109

Table 10. Estimated Annual MMPA Level B Exposures for Inland Water – DBRC Site

	TTS (Level B) Exposures	Risk Function Sub-TTS Behavioral Exposures
Killer whale	0	0
California sea lion	0	109
Harbor Seal	1,998	3,320
Total Level B Exposures (by criteria method)	1,998	3,429

Table 11. Estimated Annual MMPA Level B Exposures for Open Water – QUTR Site

	TTS (Level B) Exposures	Risk Function Sub-TTS Behavioral Exposures
Endangered & Threatened Species		
Blue whale	0	0
Fin whale	0	0
Humpback whale	0	0
Sei whale	0	0
Sperm whale	0	0
Killer whale	0	0
Steller sea lion	0	0
Non-ESA Listed Species		
Minke whale	0	0
Gray whale	0	0
Dwarf and pygmy sperm whale	0	0
Baird's beaked whale	0	0
Mesoplodons	0	0
Risso's dolphin	0	0
Pacific white-sided dolphin	0	0
Short-beaked common dolphin	0	0
Striped dolphin	0	0
Northern right whale dolphin	0	0
Dall's porpoise	0	0
Harbor porpoise*	0	11,282
Northern fur seal	0	44
California sea lion	0	5
Northern elephant seal	0	14
Harbor seal	23	78
Total Level B Exposures (by criteria method)	23	11,423

* For harbor porpoises, the model results represent the step function criteria where 100% of the population exposed to 120 dB SPL are listed. This is not a risk function calculation.

Table 12. Combined Estimated Annual MMPA Level B Exposures (TTS and Behavior) for Proposed Annual RDT&E Activities Operations at All Sites after Implementation of Proposed Mitigation Measures

	TTS (Level B) Exposures	Risk Function Sub-TTS Behavioral Exposures
Endangered & Threatened Species		
Blue whale	0	0
Fin whale	0	0
Humpback whale	0	0
Sei whale	0	0
Sperm whale	0	0
Killer whale	0	0
Steller sea lion	0	0
Non-ESA Listed Species		
Minke whale	0	0
Gray whale	0	0
Dwarf and pygmy sperm whale	0	0
Baird's beaked whale	0	0
Mesoplodons	0	0
Risso's dolphin	0	0
Pacific white-sided dolphin	0	0
Short-beaked common dolphin	0	0
Striped dolphin	0	0
Northern right whale dolphin	0	0
Dall's porpoise	0	0
Harbor porpoise*	1	11,282
Northern fur seal	0	44
California sea lion	0	114
Northern elephant seal	0	14
Harbor seal	2,062	3,507
Total Level B Exposures (by criteria method)	2,063	14,961

* For harbor porpoises, the model results represent the step function criteria where 100% of the population exposed to 120 dB SPL are listed. This is not a risk function calculation.

It is highly unlikely that a marine mammal would experience any long-term effects because the large NAVSEA NUWC Keyport Range Complex test areas make individual mammals' repeated and/or prolonged exposures to high-level sonar signals unlikely. Specifically, mid- and high-frequency acoustic sources have limited marine mammal exposure ranges and relatively high platform speeds. Moreover, there are no exposures that exceed the PTS threshold and result in Level A harassment from sonar and other active acoustic sources. Therefore, long-term effects on individuals, populations or stocks are unlikely.

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data (diving behavior, migration or movement patterns and population dynamics) used in the model, and that the model results must be interpreted within the context of a given species' ecology.

When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented with consideration of standard protective measure operating procedures. The ROP along with monitoring and mitigation measures for the Keyport Range Complex RDT&E activities, including detection of marine mammals, protective measures such as stand off distances and delaying or halting activities, and power down procedures if marine mammals are detected within one of the exclusion zones, are provided below.

Because of the time delay between pings, an animal encountering the sonar will accumulate energy for only a few sonar pings over the course of a few minutes. Therefore, exposure to sonar would be a short-term event, minimizing any single animal's exposure to sound levels approaching the harassment thresholds.

Effects on Marine Mammal Habitat

The proposed extended area for the Keyport Range Site is also critical habitat of the Southern Resident killer whales. The current Keyport Range Site is outside the critical habitat area. There are no other areas within the Keyport Range Complex with extensions that are specifically considered as important physical habitat for marine mammals.

The prey of marine mammals are considered part of their habitat. The Navy's DEIS for the Keyport Range Complex RDT&E and range extension activities contain a detailed discussion of the potential effects to fish from active acoustic sources. Below is a summary of conclusions regarding those effects.

Effects on Fish From Active Acoustic Sources

The extent of data, and particularly scientifically peer-reviewed data, on the effects of high intensity sounds on fish is limited. In considering the available literature, the vast majority of fish species studied to date are hearing generalists and cannot hear sounds above 500 to 1,500 Hz (depending upon the species), and, therefore, behavioral effects on these species from higher frequency sounds are not likely. Moreover, even those fish species that may hear above 1.5 kHz, such as a few sciaenids and the clupeids (and relatives), have relatively poor hearing above 1.5 kHz as compared to their hearing sensitivity at lower frequencies. Therefore, even among the species that have hearing ranges that overlap with some mid- and high-frequency sounds, it is likely that the fish will only actually hear the sounds if the fish and source are very close to one another. Finally, since the vast majority of sounds that are of biological relevance to fish are below 1 kHz (*e.g.,* Zelick *et al.,* 1999; Ladich and Popper, 2004), even if a fish detects a mid- or high-frequency sound, these sounds will not mask detection of lower frequency biologically relevant sounds. Based on the above information, there will likely be few, if any, behavioral impacts on fish.

Alternatively, it is possible that very intense mid- and high frequency signals could have a physical impact on fish, resulting in damage to the swim bladder and other organ systems. However, even these kinds of effects have only been shown in a few cases when the fish has been very close to the source. Such effects have never been indicated in response to any Navy sonar. Moreover, at greater distances (the distance clearly would depend on the intensity of the signal from the source) there appears to be little or no impact on fish, and particularly no impact on fish that do not have a swim bladder or other air bubble that would be affected by rapid pressure changes.

Proposed Mitigation Measures

In order to issue an incidental take authorization (ITA) under Section 101(a)(5)(A) of the MMPA, NMFS must set forth the ''permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.'' The National Defense Authorization Act (NDAA) of 2004 amended the MMPA as it relates to military-readiness activities and the incidental take authorization process such that ''least practicable adverse impact'' shall include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the ''military readiness activity.''

In addition, any mitigation measure prescribed by NMFS should be known to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

(a) Avoidance or minimization of injury or death of marine mammals wherever possible (goals b, c, and d may contribute to this goal).

(b) A reduction in the numbers of marine mammals (total number or number at a biologically important time or location) exposed to received levels underwater active acoustic sources or other activities expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing harassment takes only).

(c) A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels of underwater active acoustic sources or other activities expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing harassment takes only).

(d) A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels of underwater active acoustic sources expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing the severity of harassment takes only).

(e) A reduction in adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.

(f) For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation (shut-down zone, etc.).

NMFS worked with the Navy and identified potential practicable and effective mitigation measures, which included a careful balancing of the likely benefit of any particular measure to the marine mammals with the likely effect of that measure on personnel safety, practicality of implementation, and impact on the military readiness activity. These mitigation measures are listed below.

Proposed Mitigation Measures for Active Acoustic Sources, Surface Operations and Other Activities

Current protective measures known as the ROP employed by the NAVSEA NUWC Keyport include applicable training of personnel and implementation of activity specific procedures resulting in minimization and/or avoidance of interactions with protected resources and are provided below.

(1) Range activities shall be conducted in such a way as to ensure marine mammals are not harassed or harmed by human-caused events.

(2) Marine mammal observers are on board ship during range activities. All range personnel shall be trained in marine mammal recognition. Marine mammal observer training is normally conducted by qualified organizations such as NOAA/National Marine Mammal Lab (NMML) on an as needed basis.

(3) Vessels on a range use safety lookouts during all hours of range activities. Lookout duties include looking for any and all objects in the water, including marine mammals. These lookouts are not necessarily looking only for marine mammals. They have other duties while aboard. All sightings are reported to the Range Officer in charge of overseeing the activity.

(4) Visual surveillance shall be accomplished just prior to all in-water exercises. This surveillance shall ensure that no marine mammals are visible within the boundaries of the area within which the test unit is expected to be operating. Surveillance shall include, as a minimum, monitoring from all participating surface craft and, where available, adjacent shore sites.

(5) The Navy shall postpone activities until cetaceans (whales, dolphins, and porpoises) leave the project area. When cetaceans have been sighted in an area, all range participants increase vigilance and take reasonable and practicable actions to avoid collisions and activities that may result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (*e.g.,* safety, weather).

(6) An ''exclusion zone'' shall be established and surveillance will be conducted to ensure that there are no marine mammals within this exclusion zone prior to the commencement of each in-water exercise. For cetaceans (whales, dolphins, and porpoises), the exclusion zone must be at least as large as the entire area within which the test unit may operate, and must extend at least 1,000 yards (914.4 m) from the intended track of the test unit. For pinnipeds, the exclusion zone extends out 100 yards (91 m) from the intended track of the test unit.

(7) Range craft shall not approach within 100 yards (91 m) of marine mammals and shall be followed to the extent practicable considering human and vessel safety priorities. All Navy vessels and aircraft, including helicopters, are expected to comply with this directive. This includes marine mammals ''hauled-out'' on islands, rocks, and other areas such as buoys.

(8) Passive acoustic monitoring shall be utilized to detect marine mammals in the area before and during activities, especially when visibility is reduced.

(9) Procedures for reporting marine mammal sightings on the NAVSEA NUWC Keyport Range Complex shall be promulgated, and sightings shall be entered into the Range Operating System and forwarded to NOAA/NMML Platforms of Opportunity Program.

Research and Conservation Measures for Marine Mammals

The Navy provides a significant amount of funding and support for marine research. The Navy provided $26 million in Fiscal Year 2008 and plans for $22 million in Fiscal Year 2009 to universities, research institutions, Federal laboratories, private companies, and independent researchers around the world to study marine mammals. Over the past five years the Navy has funded over $100 million in marine mammal research. The U.S. Navy sponsors seventy percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

The Navy's Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

- Environmental Consequences of Underwater Sound,
- Non-Auditory Biological Effects of Sound on Marine Mammals,
- Effects of Sound on the Marine Environment,
- Sensors and Models for Marine Environmental Monitoring,
- Effects of Sound on Hearing of Marine Animals, and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

Furthermore, research cruises led by NMFS and by academic institutions have received funding from the Navy.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long-term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts.

Long-Term Prospective Study

NMFS, with input and assistance from the Navy and several other agencies and entities, will perform a longitudinal observational study of marine mammal strandings to systematically observe for and record the types of pathologies and diseases and investigate the relationship with potential causal factors (*e.g.,* sonar, seismic, weather). The study will not be a true ''cohort'' study, because we will be unable to quantify or estimate specific sonar or other sound exposures for individual animals that strand. However, a cross-sectional or correlational analysis, a method of descriptive rather than analytical epidemiology, can be conducted to compare population characteristics, *e.g.,* frequency of strandings and types of specific pathologies between general periods of various anthropogenic activities and non-activities within a prescribed geographic space. In the long term study, we will more fully and consistently collect and analyze data on the demographics of strandings in specific locations and consider anthropogenic activities and physical, chemical, and biological environmental parameters. This approach in conjunction with true cohort studies (tagging animals, measuring received sounds, and evaluating behavior or injuries) in the presence of activities and non-activities will provide critical information needed to further define the impacts of MTEs and other anthropogenic and non-anthropogenic stressors. In coordination with the Navy and other federal and non-federal partners, the comparative study will be designed and conducted for specific sites during intervals of the presence of anthropogenic activities such as sonar transmission or other sound exposures and absence to evaluate demographics of morbidity and mortality, lesions found, and cause of death or stranding. Additional data that will be collected and analyzed in an effort to control potential confounding factors include variables such as average sea temperature (or just season), meteorological or other environmental variables (*e.g.,* seismic activity), fishing activities, etc. All efforts will be made to include appropriate controls (*i.e.,* no sonar or no seismic); environmental variables may complicate the interpretation of ''control'' measurements. The Navy and NMFS along with other partners are evaluating mechanisms for funding this study.

Proposed Monitoring Measures

In order to issue an incidental take authorization (ITA) for an activity, section 101(a)(5)(A) of the MMPA states that NMFS must set forth ''requirements pertaining to the monitoring and reporting of such taking.'' The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for LOAs must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present.

Monitoring measures prescribed by NMFS should accomplish one or more of the following general goals:

(a) An increase in the probability of detecting marine mammals, both within the safety zone (thus allowing for more effective implementation of the mitigation) and in general to generate more data to contribute to the analyses mentioned below.

(b) An increase in our understanding of how many marine mammals are likely to be exposed to levels of HFAS/MFAS (or other stimuli) that we associate with specific adverse effects, such as behavioral harassment, TTS, or PTS.

(c) An increase in our understanding of how marine mammals respond to HFAS/MFAS (at specific received levels) or other stimuli expected to result in take and how anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival) through any of the following methods:

- Behavioral observations in the presence of HFAS/MFAS compared to observations in the absence of sonar (need to be able to accurately predict received level and report bathymetric conditions, distance from source, and other pertinent information).
- Physiological measurements in the presence of HFAS/MFAS compared to observations in the absence of sonar (need to be able to accurately predict received level and report bathymetric conditions, distance from source, and other pertinent information), and/or
- Pre-planned and thorough investigation of stranding events that occur coincident to naval activities.
- Distribution and/or abundance comparisons in times or areas with concentrated HFAS/MFAS versus times or areas without HFAS/MFAS.

(d) An increased knowledge of the affected species.

(e) An increase in our understanding of the effectiveness of certain mitigation and monitoring measures.

With these goals in mind, the following monitoring procedures for the proposed Navy's NAVSEA NUWC Keyport Range Complex RDT&E and range extension activities have been worked out between NMFS and the Navy. Keyport will conduct two special surveys per year to monitor HFAS and MFAS respectively. This will occur at the DBRC Range site. This will include visual surveys composed of vessel, shore monitoring and passive acoustic monitoring. Marine mammal observers may be on range craft and/or on shore side. NMFS and the Navy continue to improve the plan and may modify the monitoring plan based on input received during the public comment period.

Several monitoring techniques were prescribed for other Navy activities related to sonar exercises (see monitoring plan for Navy's Hawaii Range Complex; Navy, 2008). Every known monitoring technique has advantages and disadvantages that vary temporally and spatially. Therefore, a combination of techniques is proposed to be used so that the detection and observation of marine animals is maximized. Monitoring methods proposed during mission activity events in the NAVSEA NUWC Keyport Range Complex Study Area include a combination of the following research elements that would be used to collect data for comprehensive assessment:

- Visual Surveys—Vessel, Shore-based, and Aerial (as applicable)
- Passive Acoustic Monitoring (PAM)
- Marine Mammal Observers (MMOs) on Range craft

Visual Surveys

Visual surveys of marine animals can provide detailed information about their behavior, distribution, and abundance. Baseline measurements and/or data for comparison can be obtained before, during and after mission activities. Changes in behavior and geographical distribution may be used to infer if and how animals are impacted by sound. In accordance with all safety considerations, observations will be maximized by working from all available platforms: vessels, aircraft, land and/or in combination. Shore-based (for inland waters), vessel and aerial (as applicable) surveys may be conducted from shore support, range craft, Navy vessels, or contracted vessels. Visual surveys will be conducted during NAVSEA NUWC Keyport range events which are identified as being able to provide the highest likelihood of success.

Vessel surveys are often preferred by researchers because of their slow speed, offshore survey ability, duration and ability to more closely approach animals under observation. They also result in higher rate of species identification, the opportunity to combine line transect and mark-recapture methods of estimating abundance, and collection of oceanographic and other relevant data. Vessels can be less expensive per unit of time, but because of the length of time to cover a given survey area, may actually be more expensive in the long run compared to aerial surveys (Dawson *et al.,* 2008). Changes in behavior and geographical distribution may be used to infer if and how animals are impacted by sound. However, it should be noted that animal reaction (reactive movement) to the survey vessel itself is possible (Dawson *et al.,* 2008). Vessel surveys typically do not allow for observation of animals below the ocean surface (*e.g.* in the water column) as compared to aerial surveys (DoN, 2008a; Slooten *et al.,* 2004).

NAVSEA NUWC Keyport will conduct two special surveys per year to monitor HFAS and MFAS respectively. This will occur at the DBRC Range site. The determination to monitor in the DBRC area includes the following reasoning: (1) It would provide the highest amount of activity; (2) it is a controlled environment; (3) permanently bottom mounted monitoring hydrophones are in place; (4) most likely environment to get accurate data; and (5) conducive to excellent shore side observation.

For specified events, shore-based and vessel surveys will be used 1 day prior to and 1–2 days post activity. The variation in the number of days after allows for the detection of animals that gradually return to an area, if they indeed do change their distribution in response to the associated events. DBRC is a small area and animals are likely to return more quickly than if the test were in open ocean.

Surveys will include the range site with special emphasis given to the particular path of the test run. Passive acoustic system (hydrophone or towed array) would be used to determine if marine mammals are in the area before and/or after the event. When conducting a particular survey, the survey team will collect: (1) Species identification and group size; (2) location and relative distance from the acoustic source(s); (3) the behavior of marine mammals, including standard environmental and oceanographic parameters; (4) date, time and visual conditions associated with each observation; (5) direction of travel relative to the active acoustic source; and (6) duration of the observation. Animal sightings and relative distance from a particular active acoustic source will be used post-survey to determine potential received energy (dB re 1 micro Pa-sec). This data will be used, post-survey, to estimate the number of marine mammals exposed to different received levels (energy based on distance to the source, bathymetry, oceanographic conditions and the type and power of the acoustic source) and their corresponding behavior.

Although photo-identification studies are not typically a component of Navy RDT&E activity monitoring surveys, the Navy supports using the contracted platforms to obtain opportunistic data collection. Therefore, absent classification issues any unclassified digital photographs, if taken, of marine mammals during visual surveys will be provided to local researchers for their regional research if requested.

1. Shore-Based Surveys

A large number of test events in the Keyport Range complex are conducted in inland waters allowing for excellent shore based surveillance opportunities. When practicable, for test events planned adjacent to nearshore areas, where there are elevated topography or coastal structures, shore-based visual survey methods will be implemented using binoculars or theodolite. These methods have been proven valuable in similar monitoring studies such as ATOC and others (Frankel and Clark, 1998; Clark and Altman, 2006).

2. Vessel Surveys

Keyport Range Complex activities conducted in the inland waters are supported both from the shore (described above) and from range craft. The primary purpose of surveys performed from these range craft will be to document and monitor potential behavioral effects of the mission activities on marine mammals. As such, parameters to be monitored for potential effects are changes in the occurrence, distribution, numbers, surface behavior, and/or disposition (injured or dead) of marine mammal species before, during and after the mission activities. Post-analysis will focus on how the location, speed and vector of the survey vessel and the location and direction of the sonar source (*e.g.,* Navy surface vessel) relates to the animal. Any other vessels or aircraft observed in the area will also be documented.

Passive Acoustic Monitoring

There are both benefits and limitations to passive acoustic monitoring (Mellinger *et al.,* 2007). Passive acoustic monitoring (PAM) allows detection of marine mammals that vocalize but may not be seen during a visual survey. When interpreting data collected from PAM, it is understood that species specific results must be viewed with caution because not all animals within a given population are calling, or may only be calling only under certain conditions (Mellinger, 2007; ONR, 2007). The Keyport Range Complex study area has advanced features which allow for passive acoustic monitoring. These hydrophones are both permanently bottom mounted, towed or over-the-side. Subject matter experts are available for detection and identification of species type.

Marine Mammal Observer on Navy Vessels

All Keyport Range Complex operators are trained by NOAA in marine mammal identification. Additional use of civilian biologists as Marine Mammal Observers (MMOs) aboard range craft and Navy vessels may be used to research the effectiveness of Navy marine observers, as well as for data collection during other monitoring surveys.

MMOs will be field-experienced observers who are Navy biologists or contracted observers. These civilian MMOs will be placed alongside existing Navy marine observers during a sub-set of Keyport Range Complex RDT&E activities. This can only be done on certain vessels and observers may be required to have security clearance. NUWC Keyport may also use MMOs on range craft during test events being monitored. MMOs will not be placed aboard Navy platforms for every Navy testing event, but during specifically identified opportunities deemed appropriate for data collection efforts. The events selected for MMO participation will take into account safety, logistics, and operational concerns. Use of MMOs will verify Navy marine observer sighting efficiency, offer an opportunity for more detailed species identification, provide an opportunity to bring animal protection awareness to the vessels' crew, and provide the opportunity for an experienced biologist to collect data on marine mammal behavior. Data collected by the MMOs is anticipated to assist the Navy with potential improvements to marine observer training as well as providing the marine observers with a chance to gain additional knowledge on marine mammals.

Events selected for MMO participation will be an appropriate fit in terms of security, safety, logistics, and compatibility with Keyport Range Complex RDT&E activities. The MMOs will not be part of the Navy's formal vessel reporting chain of command during their data collection efforts, and Navy marine observers will follow the appropriate chain of command in reporting marine mammal sightings. Exceptions will be made if an animal is observed by the MMO within the shutdown zone and was not seen by the Navy marine observer. The MMO will inform the Navy marine observer of the sighting so that appropriate action may be taken by the chain of command. For less biased data, it is recommended that MMOs schedule their daily observations to duplicate the Navy marine observers' schedule.

Civilian MMOs will be aboard Navy vessels involved in the study. As described earlier, MMOs will meet and adhere to necessary qualifications, security clearance, logistics and safety concerns. MMOs will monitor for marine mammals from the same height above water as the Navy marine observers and as all visual survey teams, they will collect the same data collected by Navy marine observers, including but not limited to: (1) Location of sighting; (2) species (if not possible, identification of whale or dolphin); (3) number of individuals; (4) number of calves present, if any; (5) duration of sighting; (6) behavior of marine animals sighted; (7) direction of travel; (8) environmental information associated with sighting event including Beaufort sea state, wave height, swell direction, wind direction, wind speed, glare, percentage of glare, percentage of cloud cover; and (9) when in relation to navy exercises did the sighting occur.

In addition, the Navy is developing an Integrated Comprehensive Monitoring Program (ICMP) for marine species to assess the effects of Keyport Range Complex RDT&E activities on marine species and investigate population trends in marine species distribution and abundance in locations where Keyport Range Complex RDT&E activities regularly occur. As part of the ICMP, knowledge gained from other Navy MMO monitored events will be incorporated into NUWC Keyport monitoring/mitigations as part of the adaptive management approach.

The ICMP will provide the overarching coordination that will support compilation of data from range-specific monitoring plans (*e.g.,* Keyport Range Complex plan) as well as Navy funded research and development (R&D) studies. The ICMP will coordinate the monitoring program's progress toward meeting its goals and develop a data management plan. The ICMP will be evaluated annually to provide a matrix for progress and goals for the following year, and will make recommendations on adaptive management for refinement and analysis of the monitoring methods.

The primary objectives of the ICMP are to:

- Monitor and assess the effects of Navy activities on protected species;
- Ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations;
- Assess the efficacy and practicality of the monitoring and mitigation techniques;

• Add to the overall knowledge-base of marine species and the effects of Navy activities on marine species.

The ICMP will be used both as: (1) A planning tool to focus Navy monitoring priorities (pursuant to ESA/MMPA requirements) across Navy Range Complexes and Exercises; and (2) an adaptive management tool, through the consolidation and analysis of the Navy's monitoring and watchstander data, as well as new information from other Navy programs (*e.g.*, R&D), and other appropriate newly published information.

In combination with the adaptive management component of the proposed NAVSEA NUWC Keyport Range Complex rule and the other planned Navy rules (*e.g.,* Atlantic Fleet Active Sonar Training, Hawaii Range Complex, and Southern California Range Complex), the ICMP could potentially provide a framework for restructuring the monitoring plans and allocating monitoring effort based on the value of particular specific monitoring proposals (in terms of the degree to which results would likely contribute to stated monitoring goals, as well as the likely technical success of the monitoring based on a review of past monitoring results) that have been developed through the ICMP framework, instead of allocating based on maintaining an equal (or commensurate to effects) distribution of monitoring effort across Range complexes. For example, if careful prioritization and planning through the ICMP (which would include a review of both past monitoring results and current scientific developments) were to show that a large, intense monitoring effort would likely provide extensive, robust and much-needed data that could be used to understand the effects of sonar throughout different geographical areas, it may be appropriate to have other Range Complexes dedicate money, resources, or staff to the specific monitoring proposal identified as ''high priority'' by the Navy and NMFS, in lieu of focusing on smaller, lower priority projects divided throughout their home Range Complexes. The ICMP will identify:

• A means by which NMFS and the Navy would jointly consider prior years' monitoring results and advancing science to determine if modifications are needed in mitigation or monitoring measures to better effect the goals laid out in the Mitigation and Monitoring sections of this proposed Keyport Range Complex rule.

• Guidelines for prioritizing monitoring projects

• If, as a result of the Navy-NMFS 2011 Monitoring Workshop and similar to the example described in the paragraph above, the Navy and NMFS decide it is appropriate to restructure the monitoring plans for multiple ranges such that they are no longer evenly allocated (by Range Complex), but rather focused on priority monitoring projects that are not necessarily tied to the geographic area addressed in the rule, the ICMP will be modified to include a very clear and unclassified recordkeeping system that will allow NMFS and the public to see how each Range Complex/project is contributing to all of the ongoing monitoring (resources, effort, money, etc.).

Adaptive Management

Our understanding of the effects of HFAS/MFAS on marine mammals is still in its relative infancy, and yet the science in this field is evolving fairly quickly. These circumstances make the inclusion of an adaptive management component both valuable and necessary within the context of 5-year regulations for activities that have been associated with marine mammal mortality in certain circumstances and locations (though not the Keyport Range Complex Study Area). The use of adaptive management will give NMFS the ability to consider new data from different sources to determine (in coordination with the Navy), on an annual basis, if new or modified mitigation or monitoring measures are appropriate for subsequent annual LOAs. Following are some of the possible sources of applicable data:

• Results from the Navy's monitoring from the previous year (either from the Keyport Range Complex Study Area or other locations).

• Results from specific stranding investigations (either from the Keyport Range Complex Study Area or other locations, and involving coincident Keyport Range Complex RDT&E or not involving coincident use).

• Results from the research activities associated with Navy's HFAS/MFAS.

• Results from general marine mammal and sound research (funded by the Navy or otherwise).

• Any information which reveals that marine mammals may have been taken in a manner, extent or number not authorized by these regulations and subsequent Letters of Authorization.

Mitigation measures could be modified or added if new data suggest that such modifications would have a reasonable likelihood of accomplishing the goals of mitigation laid out in this proposed rule and if the measures are practicable. NMFS would also coordinate with the Navy to modify or add to the existing monitoring requirements if the new data suggest that the addition of a particular measure would more effectively accomplish the goals of monitoring laid out in this proposed rule. The reporting requirements associated with this proposed rule are designed to provide NMFS with monitoring data from the previous year to allow NMFS to consider the data in issuing annual LOAs. NMFS and the Navy will meet annually prior to LOA issuance to discuss the monitoring reports, Navy R&D developments, and current science and whether mitigation or monitoring modifications are appropriate.

Reporting

In order to issue an ITA for an activity, section 101(a)(5)(A) of the MMPA states that NMFS must set forth ''requirements pertaining to the monitoring and reporting of such taking.'' Effective reporting is critical both to monitoring compliance as well as ensuring that the most value is obtained from the required monitoring. Some of the reporting requirements are still in development and the final rule may contain additional details not contained in the proposed rule. Additionally, proposed reporting requirements may be modified, removed, or added based on information or comments received during the public comment period.

Notification of Injured or Dead Marine Mammals

Navy personnel will ensure through proper chain of command that NMFS (regional stranding coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of, any Keyport Range Complex RDT&E activities utilizing active acoustic sources. The Navy will provide NMFS with species or description of the animal (s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The Stranding Response Plan contains more specific reporting requirements for specific circumstances.

Annual Report

The Navy will submit its first annual report to the Office of Protected Resources, NMFS, no later than 120 days before the expiration of the LOA. These reports will, at a minimum, include the following information:

• The estimated number of hours of sonar and other operations involving active acoustic sources, broken down by source type.

• If possible, the total number of hours of observation effort (including observation time when sonar was not operating).

• A report of all marine mammal sightings (at any distance) to include, when possible and to the best of their ability, and if not classified:

—Species.
—Number of animals sighted.
—Location of marine mammal sighting.
—Distance of animal from any operating sonar sources.
—Whether animal is fore, aft, port, starboard.
—Direction animal is moving in relation to source (away, towards, parallel).
—Any observed behaviors of marine mammals.

• The status of any sonar sources (what sources were in use) and whether or not they were powered down or shut down as a result of the marine mammal observation.

• The platform that the marine mammals were sighted from.

Keyport Range Complex Comprehensive Report

The Navy will submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during test activities involving active acoustic sources for which annual reports are required as described above. This report will be submitted at the end of the fourth year of the rule (anticipated to be December 2013), covering activities that have occurred through June 1, 2012. The Navy will respond to NMFS comments on the draft comprehensive report if submitted within 3 months of receipt. The report will be considered final after the Navy has addressed NMFS' comments, or three months after the submittal of the draft if NMFS does not comment by then.

Analysis and Negligible Impact Determination

Pursuant to NMFS' regulations implementing the MMPA, an applicant is required to estimate the number of animals that will be ''taken'' by the specified activities (*i.e.*, takes by harassment only, or takes by harassment, injury, and/or death). This estimate informs the analysis that NMFS must perform to determine whether the activity will have a ''negligible impact'' on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.*, population-level effects). An estimate of the number of Level B harassment takes alone is not enough information on which to base an impact determination.

In addition to considering estimates of the number of marine mammals that might be ''taken'' through behavioral harassment, NMFS must consider other factors, such as the likely nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat.

The Navy's specified activities have been described based on best estimates of the planned RDT&E activities the Navy would conduct within the proposed NAVSEA NUWC Keyport Range Complex Extension. The acoustic sources proposed to be used in the NAVSEA NUWC Keyport Range Complex Extension are low intensity and total proposed sonar operation hours are under 1,570 hours. Taking the above into account, along with the fact that NMFS anticipates no mortalities and injuries to result from the action, the fact that there are no specific areas of reproductive importance for marine mammals recognized within the Keyport Range Complex Extension study area, the sections discussed below, and dependent upon the implementation of the proposed mitigation measures, NMFS has determined that Navy RDT&E activities utilizing underwater acoustic sources will have a negligible impact on the affected marine mammal species and stocks present in the proposed action area.

Behavioral Harassment

As discussed in the Potential Effects of Exposure of Marine Mammals to HFAS/MFAS and illustrated in the conceptual framework, marine mammals can respond to HFAS/MFAS in many different ways, a subset of which qualifies as harassment. One thing that the take estimates do not take into account is the fact that most marine mammals will likely avoid strong sound sources to some extent. Although an animal that avoids the sound source will likely still be taken in some instances (such as if the avoidance results in a missed opportunity to feed, interruption of reproductive behaviors, etc.) in other cases avoidance may result in fewer instances of take than were estimated or in the takes resulting from exposure to a lower received level than was estimated, which could result in a less severe response. The Keyport Range Complex application involves mid-frequency and high frequency active sonar operations shown in Table 2, and none of the tests would involve powerful tactical sonar such as the 53C series MFAS. Therefore, any disturbance to marine mammals resulting from MFAS and HFAS in the proposed Keyport Range Complex RDT&E activities is expected to be significantly less in terms of severity when compared to major sonar exercises (*e.g.*, AFAST, HRC, SOCAL). In addition, high frequency signals tend to have more attenuation in the water column and are more prone to lose their energy during propagation. Therefore, their zones of influence are much smaller, thereby making it easier to detect marine mammals and prevent adverse effects from occurring.

There is little information available concerning marine mammal reactions to MFAS/HFAS. The Navy has only been conducting monitoring activities since 2006 and has not compiled enough data to date to provide a meaningful picture of effects of HFAS/MFAS on marine mammals, particularly in the Keyport Range Complex Study Area. From the four major training exercises (MTEs) of HFAS/MFAS in the AFAST Study Area for which NMFS has received a monitoring report, no instances of obvious behavioral disturbance were observed by the Navy watchstanders in the 700+ hours of effort in which 79 sightings of marine mammals were made (10 during active sonar operation). One cannot conclude from these results that marine mammals were not harassed from HFAS/MFAS, as a portion of animals within the area of concern may not have been seen (especially those more cryptic, deep-diving species, such as beaked whales or *Kogia* sp.) and some of the non-biologist watchstanders might not have had the expertise to characterize behaviors. However, the data demonstrate that the animals that were observed did not respond in any of the obviously more severe ways, such as panic, aggression, or anti-predator response.

In addition to the monitoring that will be required pursuant to these regulations and subsequent LOAs, which is specifically designed to help us better understand how marine mammals respond to sound, the Navy and NMFS have developed, funded, and begun conducting a controlled exposure experiment with beaked whales in the Bahamas.

Diel Cycle

As noted previously, many animals perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hr cycle). Substantive behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.*, 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.*, 2007).

In the previous section, we discussed the fact that potential behavioral responses to HFAS/MFAS that fall into the category of harassment could range in severity. By definition, the takes by Level B behavioral harassment involve the disturbance of a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns (such as migration, surfacing, nursing, breeding, feeding, or sheltering) to a point where such behavioral patterns are abandoned or significantly altered. These reactions would, however, be more of a concern if they were expected to last over 24 hours or be repeated in subsequent days. Different sonar testing may not occur simultaneously. Some of the marine mammals in the Keyport Range Complex Study Area are residents and others would not likely remain in the same area for successive days, it is unlikely that animals would be exposed to HFAS/MFAS at levels or for a duration likely to result in a substantive response that would then be carried on for more than one day or on successive days.

TTS

NMFS and the Navy have estimated that individuals of some species of marine mammals may sustain some level of TTS from HFAS/MFAS operations. As mentioned previously, TTS can last from a few minutes to days, be of varying degree, and occur across various frequency bandwidths. The TTS sustained by an animal is primarily classified by three characteristics:

• Frequency—Available data (of mid-frequency hearing specialists exposed to mid to high frequency sounds—Southall *et al.*, 2007) suggest that most TTS occurs in the frequency range of the source up to one octave higher than the source (with the maximum TTS at ½ octave above).

• Degree of the shift (*i.e.*, how many dB is the sensitivity of the hearing reduced by)—generally, both the degree of TTS and the duration of TTS will be greater if the marine mammal is exposed to a higher level of energy (which would occur when the peak dB level is higher or the duration is longer). The threshold for the onset of TTS (> 6 dB) for Navy sonars is 195 dB (SEL), which might be received at distances of up to 275–500 m from the most powerful MFAS source, the AN/SQS–53 (the maximum ranges to TTS from other sources would be less). An animal would have to approach closer to the source or remain in the vicinity of the sound source appreciably longer to increase the received SEL, which would be difficult considering the marine observers and the nominal speed of a sonar vessel (10–12 knots). Of all TTS studies, some using exposures of almost an hour in duration or up to 217 dB SEL, most of the TTS induced was 15 dB or less, though Finneran *et al.* (2007) induced 43 dB of TTS with a 64-sec exposure to a 20 kHz source (MFAS emits a 1-s ping 2 times/minute).

• Duration of TTS (Recovery time)—see above. Of all TTS laboratory studies, some using exposures of almost an hour in duration or up to 217 dB SEL, almost all recovered within 1 day (or less, often in minutes), though in one study (Finneran *et al.*, 2007), recovery took 4 days.

Based on the range of degree and duration of TTS reportedly induced by exposures to non-pulse sounds of energy higher than that to which free-swimming marine mammals in the field are likely to be exposed during HFAS/MFAS testing activities, it is unlikely that marine mammals would sustain a TTS from MFAS that alters their sensitivity by more than 20 dB for more than a few days (and the majority would be far less severe). Also, for the same reasons discussed in the Diel Cycle section, and because of the short distance within which animals would need to approach the sound source, it is unlikely that animals would be exposed to the levels necessary to induce TTS in subsequent time periods such that their recovery were impeded. Additionally, though the frequency range of TTS that marine mammals might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from MFAS (the source from which TTS would more likely be sustained because the higher source level and slower attenuation make it more likely that an animal would be exposed to a higher level) would not usually span the entire frequency range of one vocalization type, much less span all types of vocalizations.

Acoustic Masking or Communication Impairment

As discussed above, it is also possible that anthropogenic sound could result in masking of marine mammal communication and navigation signals. However, masking only occurs during the time of the signal (and potential secondary arrivals of indirect rays), versus TTS, which occurs continuously for its duration. Masking effects from HFAS/MFAS are expected to be minimal. If masking or communication impairment were to occur briefly, it would be in the frequency range of MFAS, which overlaps with some marine mammal vocalizations; however, it would likely not mask the entirety of any particular vocalization or communication series because the pulse length, frequency, and duty cycle of the HFAS/MFAS signal does not perfectly mimic the characteristics of any marine mammal's vocalizations.

PTS, Injury, or Mortality

The Navy's model estimated that no marine mammal would be taken by Level A harassment (injury, PTS included) or mortality due to the low intensity of the active sound sources being used.

Based on the aforementioned assessment, NMFS preliminarily determines that there would be the following number of takes: 11,283 harbor porpoises, 44 northern fur seals, 114 California sea lions, 14 northern elephant seals, and 5,569 (5,468 Washington Inland Waters stock and 101 Oregon/Washington Coastal stock) harbor seals at Level B harassment (TTS and sub-TTS) as a result of the proposed Keyport Range Complex RDT&E sonar testing activities. These numbers do not represent the number of individuals that would be taken, since it's most likely that many individual marine mammals would be taken multiple times. However, under the worst case scenario that each animal is taken only once, it is expected that these take numbers represent approximately 29.89%, 0.01%, 0.05%, 0.01%, 37.42%, and 0.41% of the Oregon/Washington Coastal stock harbor porpoises, Eastern Pacific stock northern fur seals, U.S. stock California sea lions, California breeding stock northern elephant seals, Washington Inland Waters stock harbor seals, and Oregon/Washington Coastal stock harbor seals, respectively, in the vicinity of the proposed Keyport Range Complex Study Area (calculation based on NMFS 2007 U.S. Pacific Marine Mammal Stock Assessments and 2007 U.S. Alaska Marine Mammal Stock Assessments).

No Level A take (injury, PTS included) or mortality would occur as the result of the proposed RDT&E and range extension activities for the Keyport Range Complex.

Based on these analyses, NMFS has preliminarily determined that the total taking over the 5-year period of the regulations and subsequent LOAs from the Navy's NAVSEA NUWCX Keyport Range Complex RDT&E and range extension activities will have a negligible impact on the marine mammal species and stocks present in the Keyport Range Complex Study Area.

Subsistence Harvest of Marine Mammals

NMFS has preliminarily determined that the total taking of marine mammal species or stocks from the Navy's mission activities in the Keyport Range Complex study area would not have an unmitigable adverse impact on the availability of the affected species or stocks for subsistence uses, since there are no such uses in the specified area.

ESA

There are eight marine mammal species/stocks over which NMFS has jurisdiction that are listed as endangered or threatened under the ESA that could occur in the NAVSEA NUWCX Keyport Range Complex study area: Blue whales, fin whales, sei whales, humpback whales, North Pacific right whales, sperm whales, Southern Resident killer whales, and Steller sea lions. The Navy has begun consultation with NMFS pursuant to section 7 of the ESA, and NMFS will also consult internally on the issuance of regulations and LOAs under section 101(a)(5)(A) of the MMPA for mission activities in the Keyport Range Complex study area. Consultation will be concluded prior to a determination on the issuance of a final rule and an LOAs.

NEPA

The Navy is preparing an Environmental Impact Statement (EIS) for the proposed Keyport Range Complex RDT&E and range extension activities. A draft EIS was released for public comment from September 12–October 27, 2008 and is available at *http://www-keyport.kpt.nuwc.navy.mil.* NMFS is a cooperating agency (as defined by the Council on Environmental Quality (40 CFR 1501.6)) in the preparation of the EIS. NMFS has reviewed the Draft EIS and will be working with the Navy on the Final EIS (FEIS).

NMFS intends to adopt the Navy's FEIS, if adequate and appropriate, and we believe that the Navy's FEIS will allow NMFS to meet its responsibilities under NEPA for the issuance of the 5-year regulations and LOAs (as warranted) for mission activities in the Keyport Range Complex study area. If the Navy's FEIS is not adequate, NMFS would supplement the existing analysis and documents to ensure that we comply with NEPA prior to the issuance of the final rule and LOA.

Preliminary Determination

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat and dependent upon the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that the total taking from NAVSEA NUWC Keyport Range Complex RDT&E and range extension activities utilizing active acoustic sources in the NAVSEA NUWC Keyport Range Complex study area will have a negligible impact on the affected marine mammal species or stocks. NMFS has proposed regulations for these exercises that prescribe the means of effecting the least practicable adverse impact on marine mammals and their habitat and set forth requirements pertaining to the monitoring and reporting of such taking.

Classification

This action does not contain a collection of information requirements for purposes of the Paperwork Reduction Act.

This proposed rule has been determined by the Office of Management and Budget to be not significant for purposes of Executive Order 12866.

Pursuant to the Regulatory Flexibility Act, the Chief Counsel for Regulation of the Department of Commerce has certified to the Chief Counsel for Advocacy of the Small Business Administration that this rule, if adopted, would not have a significant economic impact on a substantial number of small entities. The RFA requires Federal agencies to prepare an analysis of a rule's impact on small entities whenever the agency is required to publish a notice of proposed rulemaking. However, a Federal agency may certify, pursuant to 5 U.S.C. 605(b), that the action will not have a significant economic impact on a substantial number of small entities. The Navy is the sole entity that will be affected by this proposed rulemaking, not a small governmental jurisdiction, small organization or small business, as defined by the RFA. This proposed rulemaking authorizes the take of marine mammals incidental to a specified activity. The specified activity defined in the proposed rule includes the use of active acoustic sources during RDT&E activities that are only conducted by and for the U.S. Navy. Additionally, the proposed regulations are specifically written for ''military readiness'' activities, as defined by the Marine Mammal Protection Act, as amended by the National Defense Authorization Act, which means that they cannot apply to small businesses. Additionally, any requirements imposed by a Letter of Authorization issued pursuant to these regulations, and any monitoring or reporting requirements imposed by these regulations, will be applicable only to the Navy. Because this action, if adopted, would directly affect the Navy and not a small entity, NMFS concludes the action would not result in a significant economic impact on a substantial number of small entities. Accordingly, no IRFA and none has been prepared.

List of Subjects in 50 CFR Part 218

Exports, Fish, Imports, Incidental take, Indians, Labeling, Marine mammals, Navy, Penalties, Reporting and recordkeeping requirements, Seafood, Sonar, Transportation.

Dated: June 30, 2009.

James W. Balsiger,

Acting Assistant Administrator for Fisheries, National Marine Fisheries Service.

For reasons set forth in the preamble, 50 CFR part 218 is proposed to be amended as follows.

PART 218—REGULATIONS GOVERNING THE TAKING AND IMPORTING OF MARINE MAMMALS

1. The authority citation for part 218 continues to read as follows:

Authority: 16 U.S.C. 1361 *et seq.*

2. Subpart S is added to part 218 to read as follows:

Subpart S—Taking Marine Mammals Incidental to U.S. Navy Research, Development, Test, and Evaluation Activities in the Naval Sea System Command Naval Undersea Warfare Center Keyport Range Complex and the Associated Proposed Extensions Study Area

Sec.

218.170 Specified activity and specified geographical area.
218.171 Permissible methods of taking.
218.172 Prohibitions.
218.173 Mitigation.
218.174 Requirements for monitoring and reporting.

218.175 Applications for Letters of Authorization.
218.176 Letters of Authorization.
218.177 Renewal of Letters of Authorization and adaptive management.
218.178 Modifications to Letters of Authorization.

Subpart S—Taking Marine Mammals Incidental to U.S. Navy Research, Development, Test, and Evaluation Activities in the Naval Sea System Command (NAVSEA) Naval Undersea Warfare Center (NUWC) Keyport Range Complex and the Associated Proposed Extensions Study Area

§ 218.170 Specified activity and specified geographical area.

(a) Regulations in this subpart apply only to the U.S. Navy for the taking of marine mammals that occur in the area outlined in paragraph (b) of this section and that occur incidental to the activities described in paragraph (c) of this section.

(b) These regulations apply only to the taking of marine mammals by the Navy that occurs within the Keyport Range Complex Action Area, which includes the extended Keyport Range Site, the extended DBRC Range Complex (DBRC) Site, and the extended Quinault Underwater Tracking Range (QUTR) Site, as presented in the Navy's LOA application. The NAVSEA NUWC Keyport Range Complex is divided into open ocean/offshore areas and in-shore areas:

(1) Open Ocean Area—air, surface, and subsurface areas of the NAVSEA NUWC Keyport Range Complex Extension that lie outside of 12 nautical miles (nm) from land.

(2) Offshore Area—air, surface, and subsurface ocean areas within 12 nm of the Pacific Coast.

(3) In-shore—air, surface, and subsurface areas within the Puget Sound, Port Orchard Reach, Hood Canal, and Dabob Bay.

(c) These regulations apply only to the taking of marine mammals by the Navy if it occurs incidental to the following activities within the designated amounts of use:

(1) Range Activities Using Active Acoustic Devices:

(i) General range tracking: Narrow frequency output between 10 to 100 kHz with source levels (SL) between 195–203 dB re 1 microPa-m.

(ii) UUV Tracking Systems: Operating frequency of 10 to 100 kHz with SLs less than 195 dB re 1 microPa-m at all range sites.

(iii) Torpedo Sonars: Operating frequency from 10 to 100 kHz with SL under 233 dB re 1 microPa-m.

(iv) Range Targets and Special Test Systems: 5 to 100 kHz frequency range with a SL less than 195 dB re 1 microPa-m at the Keyport Range Site and SL less than 238 dB re microPa-m at the DBRC and QUTR sites.

(v) Special Sonars: Frequencies vary from 100 to 2,500 kHz with SL less than 235 dB re 1 microPa-m.

(vi) Sonobuoys and Helicopter Dipping Sonar: Operate at frequencies of 2 to 20 kHz with SLs of less than 225 dB re 1 microPa-m.

(vii) Side Scan Sonar: Multiple frequencies typically at 100 to 700 kHz with SLs less than 235 dB re 1 microPa-m.

(viii) Other Acoustic Sources:

(A) Acoustic Modems: Emit pulses at frequencies from 10 to 300 kHz with SLs less than 210 dB re 1 microPa-m.

(B) Target Simulators: Operate at frequencies of 100 Hz to 10 kHz at source levels of less than 170 dB re 1 microPa-m.

(C) Aids to Navigation: Operate at frequencies of 70 to 80 kHz at SLs less than 210 dB re 1 microPa-m.

(D) Subbottom Profilers: Operate at 2 to 7 kHz at SLs less than 210 dB re 1 microPa-m, and 35 to 45 kHz at SLs less than 220 dB re 1 microPa-m.

(E) Surface Vessels, Submarines, Torpedoes, and Other UUVs: Acoustic energy from engines usually from 50 Hz to 10 kHz at SLs less than 170 dB re 1 microPa-m.

(2) Increased Tempo and Activities due to Range Extension: Proposed annual range activities and operations as listed in the following table:

Range Activity	Platform/System Used	Proposed Number of Activities/Year* Keyport Range Site	DBRC Site	QUTR Site
Test Vehicle Propulsion	Thermal propulsion systems	5	130	30
	Electric/Chemical propulsion systems	55	140	30
Other Testing Systems and Activities	Submarine testing	0	45	15
	Inert mine detection, classification and localization	5	20	10
	Non-Navy testing	5	5	5
	Acoustic & non-acoustic sensors (magnetic array, oxygen)	20	10	5
	Countermeasure test	5	50	5
	Impact testing	0	10	5
	Static in-water testing	10	10	6
	UUV test	45	120	40
	Unmanned Aerial System (UAS) test	0	2	2
Fleet Activities** (excluding RDT&E)	Surface Ship activities	1	10	10
	Aircraft activities	0	10	10
	Submarine activities	0	30	30
	Diver activities	45	5	15
Deployment Systems (RDT&E)	Range support vessels:			
	Surface launch craft	35	180	30
	Special purpose barges	25	75	0
	Fleet vessels***	15	20	20
	Aircraft (rotary and fixed wing)	0	10	20
	Shore and pier	45	30	30

* There may be several activities in 1 day. These numbers provide an estimate of types of range activities over the year.

** Fleet activities in the NAVSEA NUWC Keyport Range Complex do not include the use of surface ship and submarine hull-mounted active sonars.

*** As previously noted, Fleet vessels can include very small craft such as SEAL Delivery Vehicles.

§ 218.171 Permissible methods of taking.

(a) Under Letters of Authorization issued pursuant to §§ 216.106 and 218.176 of this chapter, the Holder of the Letter of Authorization may incidentally, but not intentionally, take marine mammals within the area described in § 218.170(b), provided the activity is in compliance with all terms, conditions, and requirements of these regulations and the appropriate Letter of Authorization.

(b) The activities identified in § 218.170(c) must be conducted in a manner that minimizes, to the greatest extent practicable, any adverse impacts on marine mammals and their habitat.

(c) The incidental take of marine mammals under the activities identified in § 218.170(c) is limited to the following species, by Level B harassment only and the indicated number of times:

(1) Harbor porpoise (*Phocoena phocoena*)—56,415 (an average of 11,283 annually),

(2) Northern fur seal (*Callorhinus ursinus*)—220 (an average of 44 annually);

(3) California sea lion (*Zalophus californianus*)—570 (an average of 114 annually);

(4) Northern elephant seal (*Mirounga angustirostris*)—70 (an average of 14 annually);

(5) Harbor seal (*Phoca vitulina richardsi)* (Washington Inland Waters stock)—27,340 (an average of 5,468 annually); and

(6) Harbor seal (*P. v. richardsi*) (Oregon/Washington Coastal stock)—505 (an average of 101 annually);

§ 218.172 Prohibitions.

Notwithstanding takings contemplated in § 218.171 and authorized by a Letter of Authorization issued under § 216.106 of this chapter and § 218.176, no person in connection with the activities described in § 218.170 may:

(a) Take any marine mammal not specified in § 218.171(b);

(b) Take any marine mammal specified in § 218.171(b) other than by incidental take as specified in § 218.171 (b);

(c) Take a marine mammal specified in § 218.171(b) if such taking results in more than a negligible impact on the species or stocks of such marine mammal; or

(d) Violate, or fail to comply with, the terms, conditions, and requirements of these regulations or a Letter of Authorization issued under § 216.106 of this chapter and § 218.176.

§ 218.173 Mitigation.

When conducting RDT&E activities identified in § 218.170(c), the mitigation measures contained in this subpart and subsequent Letters of Authorization issued under § 216.106 of this chapter and § 218.176 must be implemented. These mitigation measures include, but are not limited to:

(a) Marine mammal observers training:

(1) All range personnel shall be trained in marine mammal recognition.

(2) Marine mammal observer training shall be conducted by qualified organizations approved by NMFS.

(b) Lookouts onboard vessels:

(1) Vessels on a range shall use lookouts during all hours of range activities.

(2) Lookout duties include looking for marine mammals.

(3) All sightings of marine mammals shall be reported to the Range Officer in charge of overseeing the activity.

(c) Visual surveillance shall be conducted just prior to all in-water exercises.

(1) Surveillance shall include, as a minimum, monitoring from all participating surface craft and, where available, adjacent shore sites.

(2) When cetaceans have been sighted in the vicinity of the operation, all range participants increase vigilance and take reasonable and practicable actions to avoid collisions and activities that may result in close interaction of naval assets and marine mammals.

(3) Actions may include changing speed and/or direction, subject to environmental and other conditions (*e.g.,* safety, weather).

(d) An ''exclusion zone'' shall be established and surveillance will be conducted to ensure that there are no marine mammals within this exclusion zone prior to the commencement of each in-water exercise.

(1) For cetaceans, the exclusion zone shall extend out 1,000 yards (914.4 m) from the intended track of the test unit.

(2) For pinnipeds, the exclusion zone shall extend out 100 yards (91 m) from the intended track of the test unit.

(e) Range craft shall not approach within 100 yards (91 m) of marine mammals, to the extent practicable considering human and vessel safety priorities. This includes marine mammals ''hauled-out'' on islands, rocks, and other areas such as buoys.

(f) In the event of a collision between a Navy vessel and a marine mammal, NUWC Keyport activities shall notify immediately the Navy chain of Command, which shall notify NMFS immediately.

(g) Passive acoustic monitoring shall be utilized to detect marine mammals in the area before and during activities.

(h) Procedures for reporting marine mammal sightings on the NAVSEA NUWC Keyport Range Complex shall be promulgated, and sightings shall be entered into the Range Operating System and forwarded to NOAA/NMML Platforms of Opportunity Program.

§ 218.174 Requirements for monitoring and reporting.

(a) The Holder of the Letter of Authorization issued pursuant to § 216.106 of this chapter and § 218.176 for activities described in § 218.170(c) is required to cooperate with the NMFS when monitoring the impacts of the activity on marine mammals.

(b) The Holder of the Authorization must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in § 218.170(c) is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified or authorized in § 218.171(c).

(c) The Navy must conduct all monitoring and required reporting under the Letter of Authorization, including abiding by the NAVSEA NUWC Keyport Range Complex Monitoring Plan, which is incorporated herein by reference, and which requires the Navy to implement, at a minimum, the monitoring activities summarized below:

(1) Visual Surveys:

(i) The Holder of this Authorization shall conduct a minimum of 2 special visual surveys per year to monitor HFAS and MFAS respectively at the DBRC Range site.

(ii) For specified events, shore-based and vessel surveys shall be used 1 day prior to and 1–2 days post activity.

(A) Shore-based Surveys:

(*1*) Shore-based monitors shall observe test events that are planned in advance to occur adjacent to near shore areas where there are elevated topography or coastal structures, and shall use binoculars or theodolite to augment other visual survey methods.

(*2*) Shore-based surveys of the test area and nearby beaches shall be conducted for stranded marine animals following nearshore events. If any distressed, injured or stranded animals are observed, an assessment of the animal's condition (alive, injured, dead, or degree of decomposition) shall be reported immediately to the Navy and the information shall be transmitted immediately to NMFS through the appropriate chain of command.

(B) Vessel-based Surveys:

(*1*) Vessel-based surveys shall be designed to maximize detections of marine mammals near mission activity event.

(*2*) Post-analysis shall focus on how the location, speed and vector of the range craft and the location and direction of the sonar source (*e.g.,* Navy surface vessel) relates to the animal.

(*3*) Any other vessels or aircraft observed in the area shall also be documented.

(iii) Surveys shall include the range site with special emphasis given to the particular path of the test run. When conducting a particular survey, the survey team shall collect the following information.

(A) Species identification and group size;

(B) Location and relative distance from the acoustic source(s);

(C) The behavior of marine mammals including standard environmental and oceanographic parameters;

(D) Date, time and visual conditions associated with each observation;

(E) Direction of travel relative to the active acoustic source; and

(F) Duration of the observation.

(iv) Animal sightings and relative distance from a particular active acoustic source shall be used post-survey to determine potential received energy (dB re 1 micro Pa-sec). This data shall be used, post-survey, to estimate the number of marine mammals exposed to different received levels (energy based on distance to the source, bathymetry, oceanographic conditions and the type and power of the acoustic source) and their corresponding behavior.

(2) Passive Acoustic Monitoring (PAM):

(i) The Navy shall deploy a hydrophone array in the Keyport Range Complex Study Area for PAM.

(ii) The array shall be utilized during the two special monitoring surveys in DBRC as described in § 218.174(c)(1)(i).

(iii) The array shall have the capability of detecting low-frequency vocalizations (<1,000 Hz) for baleen whales and relatively high frequency (up to 30 kHz) for odontocetes.

(iv) Acoustic data collected from the PAM shall be used to detect acoustically active marine mammals as appropriate.

(3) Marine Mammal Observers on range craft or Navy vessels:

(i) Navy Marine mammal observers (NMMOs) may be placed on a range craft or Navy platform during the event being monitored.

(ii) The NMMO must possess expertise in species identification of regional marine mammal species and experience collecting behavioral data.

(iii) NMMOs may be placed alongside existing lookouts during the two specified monitoring events as described in § 218.174(c)(1)(i).

(iv) NMMOs shall inform the lookouts of any marine mammal sighting so that appropriate action may be taken by the chain of command. NMMOs shall schedule their daily observations to duplicate the lookouts' schedule.

(v) NMMOs shall observe from the same height above water as the lookouts, and they shall collect the same data collected by lookouts listed in § 218.174(c)(1)(iii).

(d) The Navy shall complete an Integrated Comprehensive Monitoring Program (ICMP) Plan in 2009. This planning and adaptive management tool shall include:

(1) A method for prioritizing monitoring projects that clearly describes the characteristics of a proposal that factor into its priority.

(2) A method for annually reviewing, with NMFS, monitoring results, Navy R&D, and current science to use for potential modification of mitigation or monitoring methods.

(3) A detailed description of the Monitoring Workshop to be convened in 2011 and how and when Navy/NMFS will subsequently utilize the findings of the Monitoring Workshop to potentially modify subsequent monitoring and mitigation.

(4) An adaptive management plan.

(5) A method for standardizing data collection for NAVSEA NUWC Keyport Range Complex Extension and across range complexes.

(e) Notification of Injured or Dead Marine Mammals—Navy personnel shall ensure that NMFS (regional stranding coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing underwater explosive detonations. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

(f) Annual Keyport Range Complex Monitoring Plan Report—The Navy shall submit a report annually on December 1 describing the implementation and results (through September 1 of the same year) of the Keyport Range Complex Monitoring Plan. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will also be gathered, the NMMOs collecting marine mammal data pursuant to the Keyport Range Complex Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in § 218.174(c). The Keyport Range Complex Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from Keyport Range Complex and multiple range complexes.

(g) Keyport Range Complex 5-yr Comprehensive Report—The Navy shall submit to NMFS a draft comprehensive report that analyzes and summarizes *all* of the multi-year marine mammal information gathered during tests involving active acoustic sources for which individual reports are required in § 218.174(d–f). This report will be submitted at the end of the fourth year of the rule (June 2013), covering activities that have occurred through September 1, 2013.

(h) The Navy shall respond to NMFS comments and requests for additional information or clarification on the Keyport Range Complex Extension Comprehensive Report, the Annual Keyport Range Complex Monitoring Plan Report (or the multi-Range Complex Annual Monitoring Report, if that is how the Navy chooses to submit the information) if submitted within 3 months of receipt. The report will be considered final after the Navy has addressed NMFS' comments, or three months after the submittal of the draft if NMFS does not comment by then.

(i) In 2011, the Navy shall convene a Monitoring Workshop in which the Monitoring Workshop participants will be asked to review the Navy's Monitoring Plans and monitoring results and make individual recommendations (to the Navy and NMFS) of ways of improving the Monitoring Plans. The recommendations shall be reviewed by the Navy, in consultation with NMFS, and modifications to the Monitoring Plan shall be made, as appropriate.

§ 218.175 Applications for Letters of Authorization.

To incidentally take marine mammals pursuant to these regulations for the activities identified in § 218.170(c), the U.S. Navy must apply for and obtain either an initial Letter of Authorization in accordance with § 218.176 or a renewal under § 218.177.

§ 218.176 Letters of Authorization.

(a) A Letter of Authorization, unless suspended or revoked, will be valid for a period of time not to exceed the period of validity of this subpart, but must be renewed annually subject to annual renewal conditions in § 218.177.

(b) Each Letter of Authorization will set forth:

(1) Permissible methods of incidental taking;

(2) Means of effecting the least practicable adverse impact on the species, its habitat, and on the availability of the species for subsistence uses (*i.e.,* mitigation); and

(3) Requirements for mitigation, monitoring and reporting.

(c) Issuance and renewal of the Letter of Authorization will be based on a determination that the total number of marine mammals taken by the activity as a whole will have no more than a negligible impact on the affected species or stock of marine mammal(s).

§ 218.177 Renewal of Letters of Authorization and adaptive management.

(a) A Letter of Authorization issued under § 216.106 and § 218.176 for the activity identified in § 218.170(c) will be renewed annually upon:

(1) Notification to NMFS that the activity described in the application submitted under § 218.175 shall be undertaken and that there will not be a substantial modification to the described work, mitigation or monitoring undertaken during the upcoming 12 months;

(2) Timely receipt of the monitoring reports required under § 218.174(b); and

(3) A determination by the NMFS that the mitigation, monitoring and reporting measures required under § 218.173 and the Letter of Authorization issued under §§ 216.106 and 218.176, were undertaken and will be undertaken during the upcoming annual period of validity of a renewed Letter of Authorization.

(b) If a request for a renewal of a Letter of Authorization issued under §§ 216.106 and 218.177 indicates that a substantial modification to the described work, mitigation or monitoring undertaken during the upcoming season will occur, the NMFS will provide the public a period of 30 days for review and comment on the request. Public comment on renewals of Letters of Authorization are restricted to:

(1) New cited information and data indicating that the determinations made in this document are in need of reconsideration, and

(2) Proposed changes to the mitigation and monitoring requirements contained in these regulations or in the current Letter of Authorization.

(c) A notice of issuance or denial of a renewal of a Letter of Authorization will be published in the **Federal Register**.

(d) NMFS, in response to new information and in consultation with the Navy, may modify the mitigation or monitoring measures in subsequent LOAs if doing so creates a reasonable likelihood of more effectively accomplishing the goals of mitigation and monitoring set forth in the preamble of these regulations. Below are some of the possible sources of new data that could contribute to the decision to modify the mitigation or monitoring measures:

(1) Results from the Navy's monitoring from the previous year (either from Keyport Range Complex Study Area or other locations).

(2) Findings of the Monitoring Workshop that the Navy will convene in 2011 (§ 218.174(i)).

(3) Compiled results of Navy funded research and development (R&D) studies (presented pursuant to the ICMP (§ 218.174(d)).

(4) Results from specific stranding investigations (either from the Keyport Range Complex Study Area or other locations).

(5) Results from the Long Term Prospective Study described in the preamble to these regulations.

(6) Results from general marine mammal and sound research (funded by the Navy (described below) or otherwise).

(7) Any information which reveals that marine mammals may have been taken in a manner, extent or number not authorized by these regulations or subsequent Letters of Authorization.

§ 218.178 Modifications to Letters of Authorization.

(a) Except as provided in paragraph (b) of this section and § 218.177(d), no substantive modification (including withdrawal or suspension) to the Letter of Authorization by NMFS, issued pursuant to § 216.106 of this chapter and § 218.176 and subject to the provisions of this subpart shall be made until after notification and an opportunity for public comment has been provided. For purposes of this paragraph, a renewal of a Letter of Authorization under § 218.177, without modification (except for the period of validity), is not considered a substantive modification.

(b) If the Assistant Administrator determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in § 218.171(b), a Letter of Authorization issued pursuant to § 216.106 of this chapter and § 218.176 may be substantively modified without prior notification and an opportunity for public comment. Notification will be published in the **Federal Register** within 30 days subsequent to the action.

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