DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 218

[Docket No. 0907281180–91190–01]

RIN 0648–AX90

Taking and Importing Marine Mammals; Military Training Activities and Research, Development, Testing and Evaluation Conducted Within the Mariana Islands Range Complex (MIRC)

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 for the Department of Defense (including the Navy, the U.S. Air Force (USAF), and the U.S. Marine Corps (USMC)) to take marine mammals incidental to training activities conducted in the Mariana Islands Range Complex (MIRC) study area for the period of March 2010 through February 2015 (amended from the initial request for January 2010 through December 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 November 19, 2009.

ADDRESSES: You may submit comments, identified by 0648–AX90, 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: Jolie Harrison, Office of Protected Resources, NMFS, (301) 713–2289, ext. 166.

SUPPLEMENTARY INFORMATION:

Availability

A copy of the Navy's application, as well as the draft Monitoring Plan and the draft Stranding Response Plan for MIRC, 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#applications*. The Navy's Draft Environmental Impact Statement (DEIS) for MIRC was published on January 30, 2009, and may be viewed at *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*. NMFS is participating in the development of the Navy's EIS as a cooperating agency under 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) (Pub. L. 108–136) modified the MMPA by removing the ''small numbers'' and ''specified geographical region'' limitations 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

In August 2008, NMFS received an application from the Navy (which was updated in February, March, and June 2009) requesting authorization for the take of individuals of 28 species of marine mammals incidental to upcoming Department of Defense (including Navy, USMC, and USAF) training activities to be conducted from March 2010 through February 2015 within the MIRC study area, which encompasses a 501,873-square-nautical mile (nm^2) area around the islands of Guam, Tinian, Saipan, Rota, Fallaron de Medenillia, and others and includes ocean areas in both the Pacific Ocean and the Philippine Sea. These training activities are classified as military readiness activities under the provisions of the NDAA. The Navy states, and NMFS concurs, that these military readiness activities may incidentally take marine mammals present within the MIRC Study Area by exposing them to sound from mid-frequency or high frequency active sonar (MFAS/HFAS) or underwater detonations. The Navy requests authorization to take individuals of 27 species of marine mammals by Level B Harassment and 2 individuals of 2 species by Level A Harassment, although injury will likely be avoided through the implementation of the Navy's proposed mitigation measures. Further, although it does not anticipate that it will occur, the Navy requests authorization to take, by injury or mortality, up to 10 beaked whales over the course of the 5-yr regulations.

Description of Specified Activities

Purpose and Background

The Navy's mission is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. Section 5062 of

Title 10 of the United States Code directs the Chief of Naval Operations to train all military forces for combat. The Chief of Naval Operations meets that direction, in part, by conducting at-sea training exercises and ensuring naval forces have access to ranges, operating areas (OPAREAs) and airspace where they can develop and maintain skills for wartime missions and conduct research, development, testing, and evaluation (RDT&E) of weapons systems.

The specified training and RDT&E activities addressed in this proposed rule are a subset of the Proposed Action described in the MIRC DEIS, which would support and maintain Department of Defense training and assessments of current capabilities, RDT&E activities, and associated range capabilities (including hardware and infrastructure improvements in the MIRC). Training and RDT&E do not include combat operations, operations in direct support of combat, or other activities conducted primarily for purposes other than training. The Department of Defense proposes to implement actions within the MIRC to:

• Maintain baseline training and RDT&E activities at mandated levels;

• Provide the potential to increase training activities and exercises from current levels;

• Accommodate increased readiness activities associated with the force structure changes (human resources, new platforms, additional weapons systems, including underwater tracking capabilities and training activities to support Intelligence, Surveillance, Reconnaissance, Strike [ISR/Strike]); and

• Implement range complex investment strategies that sustain, upgrade, modernize, and transform the MIRC to accommodate increased use and more realistic training scenarios.

The proposed action would result in the following increases (above those conducted in previous years, i.e., the No Action Alternative in the Navy's DEIS) in activities associated with the annual take of marine mammals:

• Multistrike Exercises and Joint Expeditionary Exercises (most extensive at sea exercises utilizing MFAS)—increase from one exercise in alternate years to one exercise every year.

• Other Major Exercises utilizing MFAS (shorter and less MFAS use)—increase from 1 to 7 exercises.

• Unit Level Anti-submarine Warfare (ASW) Exercises (TRACKEX and TORPEX)—an increase from 34 to 83 exercises.

• Mine Warfare Exercises—an increase from 32 to 53 exercises.

• Bombing Exercises (non-inert)—an increase from 1 to 4 exercises.

• Sinking Exercises—an increase from 1 to 2 exercises.

• Gunnery Exercises—an increase from 32 to 54 exercises.

• Missile Exercises (Air to Surface, live HELLFIRE missile)—an increase from 0 to 2 exercises.

Overview of the MIRC

The U.S. military has been training and operating in the area now defined as the MIRC for over 100 years. The MIRC Study Area (see figure 1–1 in the Navy's application) is located in the Western Pacific (WestPac) and consists of three primary components: ocean surface and undersea areas, special use airspace (SUA), and training land areas. The ocean surface and undersea areas extend from the international waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the middle of the Philippine Sea to the west, encompassing 501,873 square nautical miles (nm^2) (1,299,851 square kilometers [km^2]) of open ocean and littorals (coastal areas). The MIRC Study Area includes ocean areas in the Philippine Sea, Pacific Ocean, and exclusive economic zones (EEZs) of the United States and Federal States of Micronesia (FSM). The MIRC Study Area includes land ranges and training area/facilities on Guam, Rota, Tinian, Saipan, and Farallon de Medinilla (FDM), encompassing 64 nm^2 (220 km^2) of land. Special Use Airspace (SUA) consists of Warning Area 517 (W–517), restricted airspace over FDM (R–7201), and Air Traffic Control Assigned Airspace (ATCAA) encompassing 63,000 nm^2 (216,000 km^2) of airspace. For range management and scheduling purposes, the MIRC is divided into training areas under different controlling authorities.

Guam is located roughly three quarters of the distance from Hawaii to the Philippines, about 1,600 miles east of Manila and 1,550 miles southeast of Tokyo. The southern extent of the Commonwealth of the Northern Mariana Islands (CNMI) is located 40 miles north of Guam (Rota Island) and extends 330 miles to the northwest. Saipan, the CNMI capital, is 3,300 miles west of Honolulu and 1,470 miles south-southeast of Tokyo. The MIRC is of particular significance for the training of U.S. military forces in the Western Pacific because of its location. As the westernmost complex in U.S. territory, it provides the only opportunity for forward-deployed U.S. forces to train on U.S.-owned lands without having to return to Hawaii or the continental United States.

The seafloor of the MIRC is characterized by the Mariana Trench, the Mariana Basin, the Mariana Ridge, ridges, numerous seamounts, hydrothermal vents, and volcanic activity. These areas are comprised of very deep water with a very rapid transition from the shelf to deep water. The Mariana Trench is located east to south-east of Guam and the Mariana Islands and is characterized by deep depths of 16,404 to 32,808 feet [ft] (5,000 to 10,000 m) (Fryer *et al.*, 2003). The Mariana Basin is located west of Guam and the Mariana Islands, and is characterized by an average depth of 11,483 ft (Taylor and Martinez 2003; Yamazaki *et al.*, 1993). The Mariana Ridge consists of Guam and the Mariana Islands and the waters out to the Mariana Trench, and is characterized by shallow water transitioning to deep water of 11,483 ft (3,500 m) (Taylor and Martinez 2003; Yamazaki *et al.*, 1993). The bottom substrate covering the seafloor in the MIRC is primarily volcanic or marine in nature (Eldredge, 1983).

The waters of the MIRC Study Area undergo an annual cycle of temperature change, however this temperature flux is only a few degrees each year, as would be expected from a tropical climate. The temperature throughout the year ranges from about 25° to 31 °C with an annual mean temperature of 27° to 28 °C for the years ranging from 1984 to 2003 (National Oceanic and Atmospheric Administration [NOAA] 2004). Temperatures increase during the summer and autumn months with peak temperatures occurring in September/October.

The water column in the MIRC Study Area contains a well-mixed surface layer ranging from 295 ft to 410 ft (90 to 125 m). Immediately below the mixed layer is a rapid decline in temperature to the cold deeper waters. Unlike more temperate climates, the thermocline is relatively stable, rarely turning over and mixing the more nutrient-rich waters of the deeper ocean in to the surface layer. This constitutes what has been defined as a ''significant'' surface duct (a mixed layer of constant water temperature extending from the sea surface to 100 feet or more), which influences the transmission of sound in the water. This factor has been included in the modeling analysis of marine mammal impacts.

Marianas Trench Marine National Monument

The Marianas Trench Marine National Monument (the 'Monument') was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431). The Monument consists of approximately 71,897 square nautical miles (246,600 square kilometers) of submerged lands and waters of the Mariana Archipelago and was designated with the purpose of protecting the submerged volcanic areas of the Mariana Ridge, the coral reef ecosystems of the waters surrounding the islands of Farallon de Pajaros, Maug, and Asuncion in the Commonwealth of the Northern Mariana Islands, and the Mariana Trench. The Monument includes the waters and submerged lands of the three northernmost Mariana Islands (the 'Islands Unit') and only the submerged lands of designated volcanic sites (the 'Volcanic Unit') and the Mariana Trench (the 'Trench Unit') to the extent described as follows: The seaward boundaries of the Islands Unit of the monument extend to the lines of latitude and longitude which lie approximately 50 nautical miles (93 kilometers) from the mean low water line of Farallon de Pajaros (Uracas), Maug, and Asuncion. The inland boundary of the Islands Unit of the monument is the mean low water line. The boundary of the Trench Unit of the Monument extends from the northern limit of the EEZ of the United States in the Commonwealth of the Northern Mariana Islands to the southern limit of the Exclusive Economic Zone of the United States in Guam approximately following the points of latitude and longitude identified in Figure 3.6–1 of the MIRC DEIS. The boundaries of the Volcanic Unit of the Monument include a 1 nautical mile radius centered on each of the islands' volcanic features.

The Monument contains objects of scientific interest, including the largest active mud volcanoes on Earth. The Champagne vent, located at the Eifuku submarine volcano, produces almost pure liquid carbon dioxide. This phenomenon has only been observed at one other site in the world. The Sulfur Cauldron, a pool of liquid sulfur, is found at the Daikoku submarine volcano. The only other known location of molten sulfur is on Io, a moon of Jupiter. Unlike other reefs across the Pacific, the northernmost Mariana reefs provide unique volcanic habitats that support marine biological communities requiring basalt. Maug Crater represents one of only a handful of places on Earth where photosynthetic and chemosynthetic communities of life are known to come together.

The waters of the Monument's northern islands are among the most biologically diverse in the Western Pacific and include the greatest diversity of seamount and hydrothermal vent life yet discovered. These volcanic islands are ringed by coral ecosystems with very high numbers of apex predators, including large numbers of sharks. They also contain one of the most diverse collections of stony corals in the Western Pacific. The northern islands and shoals in the Monument have substantially higher large fish biomass, including apex predators, than the southern islands and Guam. The waters of Farallon de Pajaros (also known as Uracas), Maug, and Asuncion support some of the largest biomass of reef fishes in the Mariana Archipelago.

A portion of the Monument lies within the MIRC, including a small area on the northern border of the MIRC as well as the Volcanic Unit and the Trench Unit (See Figure 3.6–1). Any of the activities identified under the Proposed Action could take place within areas included in the Monument, where they overlap. The Presidential Proclamation establishing the Monument indicates that the prohibitions required by the Proclamation shall not apply to activities and exercises of the Armed Forces, but also that the Armed Forces shall ensure, by the adoption of appropriate measures not impairing operations or operational capabilities, that its vessels and aircraft act in a manner consistent, so far as is reasonable and practicable, with the Proclamation.

Specified Activities

As mentioned above, the Navy has requested MMPA authorization to take marine mammals incidental to training or RDT&E activities in the MIRC that would result in the generation of sound or pressure waves in the water at or above levels that NMFS has determined will likely result in take (see Acoustic Take Criteria Section), either through the use of MFAS/HFAS or the detonation of explosives in the water. These activities are discussed in the subsections below. In addition to use of active sonar sources and explosives, these activities include the operation and movement of vessels that are necessary to conduct the training, and the effects of this part of the activities are also analyzed in this document.

The Navy's application also briefly summarizes Maritime and Air Interdiction of Maritime Targets and Air Combat Maneuvers; however, these activities are primarily air based and do not utilize sound sources or explosives in the water. No take of marine mammals is anticipated to result from these activities and, therefore, they are not discussed further.

Activities Utilizing Active Sonar Sources

For the MIRC, the training activities that utilize active tactical sonar sources fall primarily into the category of Anti-submarine Warfare (ASW). This section includes a description of ASW, the active acoustic devices used in ASW exercises, and the exercise types in which these acoustic sources are used.

ASW Training and Active Sonar

ASW involves helicopter and sea control aircraft, ships, and submarines, operating alone or in combination, to locate, track, and neutralize submarines. Various types of active and passive sonars are used by the Navy to determine water depth, locate mines, and identify, track, and target submarines. Passive sonar ''listens'' for sound waves by using underwater microphones, called hydrophones, which receive, amplify and process underwater sounds. No sound is introduced into the water when using passive sonar. Passive sonar can indicate the presence, character and movement of submarines. However, passive sonar provides information about only the bearing (direction) to a sound-emitting source; it does not provide an accurate range (distance) to the source. Also, passive sonar relies on the underwater target itself to provide sufficient sound to be detected by hydrophones. Active sonar is needed to locate objects that emit little or no noise (such as mines or diesel-electric submarines operating in electric mode) and to establish both bearing and range to the detected contact.

Active sonar transmits pulses of sound that travel through the water, reflect off objects and return to a receiver. By knowing the speed of sound in water and the time taken for the sound wave to travel to the object and back, active sonar systems can quickly calculate direction and distance from the sonar platform to the underwater object. There are three types of active sonar: Low frequency, mid-frequency, and high-frequency.

MFAS, as defined in the Navy's MIRC LOA application, operates between 1 and 10 kHz, with detection ranges up to 10 nm (19 km). Because of this detection ranging capability, MFAS is the Navy's primary tool for conducting ASW. Many ASW experiments and exercises have demonstrated that the improved capability (of MFAS over other sources) for long range detection of adversary submarines before they are able to conduct an attack is essential to U.S.

ship survivability. Today, ASW is the Navy's number one war-fighting priority. Navies across the world utilize modern, quiet, diesel-electric submarines that pose the primary threat to the U.S. Navy's ability to perform a number of critical missions. Extensive training is necessary if Sailors on ships and in strike groups are to gain proficiency in using MFAS. If a strike group does not demonstrate MFAS proficiency, it cannot be certified as combat ready.

HFAS, as defined in the Navy's MIRC LOA application, operates at frequencies greater than 10 kilohertz (kHz). At higher acoustic frequencies, sound rapidly dissipates in the ocean environment, resulting in short detection ranges, typically less than five nm (9 km). High-frequency sonar is used primarily for determining water depth, hunting mines and guiding torpedoes.

Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar operates below 1 kHz and is designed to detect extremely quiet diesel-electric submarines at ranges far beyond the capabilities of MFA sonars. There are currently only two ships in use by the Navy that are equipped with LFA sonar; both are ocean surveillance vessels operated by Military Sealift Command (MSC).

Acoustic Sources Used for ASW Exercises in the MIRC

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit omni-directional pulses (''pings'') and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonar emits an omni-directional ping and then rapidly scans a steered receiving beam to provide directional, as well as range, information. More advanced active sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range. The types of active sonar sources employed during ASW active sonar training exercises in the MIRC are identified in Table 1.

The SURTASS LFA system may also be used during some of the Navy's training and testing scenarios within the MIRC Study Area (see SURTASS LFA subsection below), however, that system's use was analyzed in other environmental documentation (DON 1999, 2002b, 2007a; NOAA 2002a, 2007).

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Sonar Sources	Freq-uency (kHz)	Source Level (dB) re 1 µPa @ 1 m	Emission Spacing (m)*	Vertical Direct-ivity	Horizon-tal Direct-ivity	Associated Platform	System Description	Annual Amount	Unit
AN/SQS-53C	3.5	235	154	Omni	240° forward-looking	Cruiser (CG) and Destroyer (DDG) hull mounted sonar	ASW search, detection, & localization (approximately 120 pings per hour)	1989-summer / 184-winter	Hours
AN/SQS-56C	7.5	225	129	13°	30°	Frigate (FFG) hullmounted sonar	ASW search, detection, & localization (approximately 120 pings per hour)	109-summer / 32-winter	Hours
AN/AQS-22	Classifed (HF)	Classified				Helicopter Dipping sonar	ASW search, detection, & localization (10 pings/dip, 30 seconds between pings), also used to represent AN/AQS-13	440-summer / 152-winter	Hours
AN/BQQ-10	Classifed (HF)	Classified				Submarine hull-mounted sonar	ASW search and attack (approximately one ping per two hours when in use)	6-summer / 6 winter	Hours
AN/SSQ-62 DICASS (sonobuoy, tonal)	8	201	450	Omni	Omni	Helicopter and maritime patrol aircraft (P3 and P8 MPA) dropped sonobuoy	Remotely commanded expendable sonar-equipped buoy (approximately 12 pings per use, 30 secs between pings, 8 buoys per hour)	1568-summer / 86-winter	Buoys
MK-48 torpedo sonar	Classified (>10)	Classified	144	Omni	Omni	Submarine (SSN) launched torpedo (used during TORPEX)	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run	20-summer / 20-winter	Torpedoes
AN/SSQ-110A (IEER)	Classified (impulsive, broadband)	Classified	n/a	Omni	Omni	MPA deployed	ASW system consists of explosive acoustic source buoy (contains two 4.1 lb charges) and expendable passive receiver sonobuoy	102-summer / 4-winter	Buoys
AN/SSQ-125 (AEER)	1	Classified	15	Omni	Omni	MPA deployed	ASW system consists of active sonobuoy and expendable passive receiver sonobuoy	102-summer / 4-winter	Buoys
MK-84 Range Pingers	12.9 or 37 (rare)	194	Ping dur. 15 msec / ping every 2 sec	90°		Ships, submarines, weapons, targets, and UUV (8-10 knot platform)	4 pingers max used during a PUTR TORPEX or TRACKEX exercise. Surface ship pingers are at 7 m depth / target or sub pingers at 100 m depth. 8 hours total event duration each during PUTR operational days.	280	Hours
PUTR Transponder	8.8 or 40	186 or 190	n/a		180 upward-looking	Portable Undersea Tracking Range, deployed on ocean floor	2 pingers used 8 hrs per event. One ping every 2 seconds.	280	Hours

Table 1. Active sonar sources in the MIRC and parameters used for modeling them. Many of the actual parameters and capabilities of these sonars are classified. Parameters used for modeling were derived to be as representative as possible. When, however, there were a wide range of potential modeling values, a nominal parameter likely to result in the most impact was used so that the model would err towards overestimation.

*Spacing means distance between pings at the nominal speed

CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; FFG – Fast Frigate; HF – High-Frequency; MF – Mid-Frequency.

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ASW sonar systems are deployed from certain classes of surface ships, submarines, helicopters, and fixed-wing maritime patrol aircraft (MPA). Maritime patrol aircraft is a category of fixed-wing aircraft that includes the current P–3C Orion, and the future P–8 Poseidon multimission maritime aircraft. The surface ships used are typically equipped with hull-mounted sonars (passive and active) for the detection of submarines. Fixed-wing MPA are used to deploy both active and passive sonobuoys to assist in locating and tracking submarines or ASW targets during the exercise. Helicopters are used to deploy both active and passive sonobuoys to assist in locating and tracking submarines or ASW targets during the exercise, and to deploy dipping sonar. Submarines are equipped with passive sonar sensors used to locate and prosecute other submarines and/or surface ships during the exercise. The platforms used in ASW exercises are identified below.

Surface Ship Sonars—A variety of surface ships participate in training events, including the Fast Frigate (FFG) and the Guided Missile Destroyer (DDG), and the guided missile cruiser (CG). These three classes of ship are equipped with active as well as passive tactical sonars for mine avoidance and submarine detection and tracking. DDG and CG class ships are equipped with the AN/SQS–53 sonar system (the most powerful system), with a nominal source level of 235 decibels (dB) re 1 μPa @ 1 m. The FFG class ship uses the SQS–56 sonar system, with a nominal source level of 225 decibels (dB) re 1 μPa @ 1 m. Sonar ping transmission durations were modeled as lasting 1 second per ping and omni-directional, which is a conservative assumption that will overestimate potential effects. Actual ping durations will be less than 1 second. The AN/SQS–53 hull-mounted sonar transmits at a center frequency of 3.5 kHz. The SQS–56 transmits at a center frequency of 7.5 kHz. Details concerning the tactical use of specific frequencies and the repetition rate for the sonar pings is classified but was modeled based on the required tactical training setting.

Submarine Sonars—Submarine sonars (e.g., AN/BQQ–10) are used to detect and target enemy submarines and surface ships. Because submarine active sonar use is very rare and in those rare instances, very brief, it is extremely unlikely that use of active sonar by submarines would have any measurable effect on marine mammals. In addition, submarines have a high frequency AN/BQS–15 sonar used for navigation safety and mine avoidance that is not unlike a fathometer in source level or output. There is, at present, no mine training range in the MIRC area. Therefore, given its limited use and rapid attenuation as a high frequency source, the AN/BQS–15 is not expected to result in the take of marine mammals.

Aircraft Sonar Systems—Aircraft sonar systems that would operate in the MIRC include sonobuoys and dipping sonar. Sonobuoys may be deployed by maritime patrol aircraft or helicopters; dipping sonars are used by carrier-based helicopters. A sonobuoy is an expendable device used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Most sonobuoys are passive, but some can generate active acoustic signals, as well. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. During ASW training, these systems' active modes are only used briefly for localization of contacts and are not used in primary search capacity.

Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) Systems—EER/IEER are airborne ASW systems used to conduct ''large area'' searches for submarines. These systems are made up of airborne avionics ASW acoustic processing and sonobuoy types that are deployed in pairs. The EER/IEER System's active sonobuoy component, the AN/SSQ–110A Sonobuoy, generates an explosive sound impulse and a passive sonobuoy (ADAR, AN/SSQ–101A) that would ''listen'' for the return echo that has been bounced off the surface of a submarine. These sonobuoys are designed to provide underwater acoustic data necessary for naval aircrews to quickly and accurately detect submerged submarines. The sonobuoy pairs are dropped from a maritime patrol aircraft into the ocean in a predetermined pattern with a few buoys covering a very large area. The AN/SSQ–110A Sonobuoy Series is an expendable and commandable sonobuoy. Upon command from the aircraft, the explosive charge would detonate, creating the sound impulse. Within the sonobuoy pattern, only one detonation is commanded at a time. Twelve to twenty SSQ–110A source sonobuoys are used in a typical exercise. Both charges of each sonobuoy would be detonated independently during the course of the training, either tactically to locate the submarine, or when the sonobuoys are commanded to scuttle at the conclusion of the exercise. The AN/SSQ–110A is listed in Table 1 because it functions like a sonar ping, however, the source creates an explosive detonation and its effects are considered in the underwater explosive section.

Advanced Extended Echo Ranging (AEER) System—The proposed AEER system is operationally similar to the existing EER/IEER system. The AEER system will use the same ADAR sonobuoy (SSQ–101A) as the acoustic receiver and will be used for a large area ASW search capability in both shallow and deep water. However, instead of using an explosive AN/SQS–110A as an impulsive source for the active acoustic wave, the AEER system will use a battery powered (electronic) source for the AN/SSQ 125 sonobuoy. The output and operational parameters for the AN/SSQ–125 sonobuoy (source levels, frequency, wave forms, etc.) are classified. However, this sonobuoy is intended to replace the EER/IEER's use of explosives and is scheduled to enter the fleet in 2011. For purposes of analysis, replacement of the EER/IEER system by the AEER system will be assumed to occur at 25% per year as follows: 2011—25% replacement; 2012—50% replacement; 2013—75% replacement; 2014—100% replacement with no further use of the EER/IEER system beginning in 2015 and beyond.

Torpedoes—Torpedoes are the primary ASW weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for guidance. The MK–48 submarine-launched torpedo was modeled for active sonar transmissions as a high frequency source during specified training activities within the MIRC. The use of the less powerful MK–46 and MK–54 torpedoes will also occur in the MIRC, however, their use was accounted for by modeling all torpedo use in MIRC as if they were MK–48 torpedoes.

Portable Undersea Tracking Range—The Portable Undersea Tracking Range (PUTR) would be developed to support ASW training in areas where the ocean depth is between 400 m and 3500 m. In MIRC it would likely be deployed in a TORPEX area or in W–517. This system would temporarily instrument up to a 100 square-nautical mile or smaller areas on the seafloor, and would provide high fidelity crew feedback and scoring of crew performance during ASW training activities. No on-shore construction would take place. Seven electronics packages, each approximately 3 ft long by 2 ft in diameter, would be temporarily installed on the seafloor by a range boat. The anchors used to keep the electronics packages on the seafloor are made of steel, approximately 1.5 ft-by-1.5 ft and 300 pounds. PUTR use is planned for Navy training areas other than MIRC including the Northwest Training Range Complex and Gulf of Alaska. PUTR equipment can be recovered for maintenance or when training is completed. The Navy proposes to deploy this system year round, and to conduct TRACKEX and TORPEX activities for up to 35 days per year at any time of year. During each of the 35 days of annual operation, the PUTR would be in use for up to 8 hours each day. Two separate sound sources are associated with the operation of the PUTR:

• Range tracking pingers—Range tracking pingers would be used on ships, submarines, and ASW targets when training is conducted on the PUTR. A typical MK 84 range tracking pinger generates a 12.9 kHz pulse with a duty cycle of 15 milliseconds and has a design power of 194 dB re 1 micro-Pascal at 1 meter. Ping rate is selectable and typically one pulse every two seconds. Under the proposed action, up to four range pingers would operate simultaneously for 8 hours each of the 35 PUTR operating days per year. Total time operated would be 280 hours annually.

• Transponders—Each transponder package consists of a hydrophone that receives pinger signals, and a transducer that sends an acoustic ''uplink'' of locating data to the range boat. The uplink signal is transmitted at 8.8 kilohertz (kHz) or 40 kHz, at a source level of 190 decibels (dB) at 40 kHz, and 186 dB at 8.8 kHz. The uplink frequency is selectable and typically uses the 40 kHz signal, however the lower frequency may be used when PUTR is deployed in deep waters where conditions may not permit the 40 kHz signal to establish and maintain the uplink. The PUTR system also incorporates an emergency underwater voice capability that transmits at 8–11 kHz and a source level of 190 dB. Under the proposed action, the uplink transmitters would operate 35 days per year, for 8 hours each day of use. Total time operated would be 280 hours annually.

Acoustic Device Countermeasures (ADCs)—ADCs (e.g., AN/SLQ–25 (''NIXIE''), MK–2 and MK–3 are, in effect, decoys to avert localization and/or torpedo attacks. These do not represent a significant source of sound given their intermittent use and operational characteristics (source output level and/or frequency). Given the sporadic use of these devices, the potential to affect marine mammals is unlikely, therefore these sources were not modeled or considered further in this analysis.

Training Targets—ASW training targets are used to simulate opposition submarines. They are equipped with one or a combination of the following devices: (1) Acoustic projectors emanating sounds to simulate submarine acoustic signatures, (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine, and (3) magnetic sources to trigger magnetic detectors. Based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals is unlikely, and therefore they were not modeled for this analysis.

SURTASS LFA—SURTASS LFA is a long-range, all-weather, sonar system that operates in the low frequency band (100–500 Hz). The system has both passive and active components. The active system component, LFA, is an augmentation to the passive detection system, and is planned for use when passive system performance proves inadequate. LFA is a set of acoustic transmitting source elements suspended by cable from underneath a ship. These elements, called projectors, are devices that produce the active sound pulse, or ping. The projectors transform electrical energy to mechanical energy that set up vibrations or pressure disturbances within the water to produce a ping. The passive, or listening, part of the system is SURTASS, which detects returning echoes from submerged objects, such as submarines, through the use of hydrophones. The SURTASS hydrophones are mounted on a receive array that is towed behind the vessel. The return signals or echoes, which are usually below background or ambient sound level, are then processed and evaluated to identify and classify potential underwater targets.

In the MIRC Study Area, the military intends to conduct three exercises (multi-strike group exercises) that will include an LFA component during a five-year period that may include both SURTASS LFA and MFA active sonar sources. The expected duration of these combined exercises is approximately 14 days. Based on an exercise of this length, an LFA system would be active (i.e., actually transmitting) for no more than approximately 25 hours. In the combined exercise, LFA sonar is used as a long-range search tool (to find a potential target at long range) while MFA sonar is generally used as a closer-range search tool (to find a target at closer range). The LFA sonar and the MFA sonar would not normally be operated in close proximity to each other. Tactical and technical considerations dictate that the LFA ship would typically be tens of miles from the MFA ship when using active sonar.

Analysis of the environmental impacts of the SURTASS LFA system, including the potential for synergistic and cumulative effects with MFAS operation, was previously presented in a series of Navy EISs and the August, 2009 biological opinion for SURTASS LFA 2009 LOA, and the take of marine mammals incidental to the operation of LFA in the MIRC and elsewhere has been previously authorized by NOAA/NMFS (2002a, 2007). Although the authorization of take of marine mammals incidental to the operation of LFA sonar will not be considered here, NMFS describes and considers the limited manner in which the two separately analyzed systems (LFAS and MFAS) may interact in a multi-strike group exercise in the MIRC.

Exercises Utilizing MFAS in the MIRC

As described above, ASW Exercises are the primary type of exercises that utilize MFAS and HFAS sources in the MIRC. Unit level tracking and torpedo ASW exercises occur regularly in the MIRC. Additionally, in a single year the MIRC will either have several major exercises, or one multi-strike group exercise, that integrate ASW training with other types of training such as air, surface, or strike warfare. ASW exercise descriptions are included below and summarized (along with the exercises utilizing explosives) in Table 2.

ASW Tracking Exercise (TRACKEX)—Generally, TRACKEXs train aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. ASW Tracking Exercises occur during both day and night. A typical unit-level exercise involves one (1) ASW unit (aircraft, ship, or submarine) versus one (1) target—either a MK–39 Expendable Mobile ASW Training Target (EMATT), or a live submarine. The target may be non-evading while operating on a specified track or fully evasive. Participating units use active and passive sensors, including hull-mounted sonar, towed arrays, and sonobuoys for tracking. If the exercise continues into the firing of a practice torpedo it is termed a Torpedo Exercise (TORPEX). The ASW TORPEX usually starts as a TRACKEX to achieve the firing solution. The different types of TORPEXs are further described below.

Torpedo Exercise (TORPEX)—Anti-submarine Warfare (ASW) TORPEX activities train crews in tracking and attack of submerged targets, firing one or two exercise torpedoes (EXTORPs) or recoverable exercise torpedoes (REXTORPs). TORPEX targets and systems used in the Offshore Areas may include live submarines, MK–46, MK–54, and MK–48 torpedoes, MK–30 ASW training targets, and MK–39 Expendable Mobile ASW Training Targets (EMATTs). The target may be non-evading while operating on a specified track, or it may be fully evasive, depending on the training requirements of the training exercise. Submarines periodically conduct torpedo firing training exercises within the MIRC. Typical duration of a submarine TORPEX exercise is 10 hours, while air and surface ASW platform TORPEX exercises using the MK–46 and MK–54 torpedoes are considerably shorter.

Joint Expeditionary Exercise—The Joint Expeditionary Exercise brings different branches of the U.S. military together in a joint environment that includes planning and execution efforts as well as military operations at sea, in the air, and ashore. The purpose of the exercise is to train a U.S. Joint Task Force staff in crisis action planning for execution of contingency operations. It provides U.S. forces an opportunity to practice training together in a joint environment as well as a combined environment with partner nation forces, where more than 8,000 personnel may participate.

The participants and assets could include: Carrier Strike Group with its aircraft carrier, guided missile cruisers and Guided missile destroyers; Amphibious command and assault ships, submarines, logistic ships. It may also include Fleet and Battle Group Staffs, Naval and Air Force aircraft, Marine Expeditionary Units (MEU), and Army Infantry Units. This type of exercise would include activities conducted at sea and in the air and near-shore and ashore activities on Tinian, FDM, Guam, and Saipan.

ASW active sonar activity may include: Single and multi-unit TRACKEX and TORPEX in coordinated ASW events; active ASW sources may include SQS–53; SQS–56; DICASS; IEER/AEER; AQS–22; BQQ–10; MK–48 EXTORP; and, Portable Underwater Tracking Range operation including transponders and MK–84 range tracking pingers.

Marine Air Ground Task Force (Amphibious) (MAGTF) Exercise—This major exercise includes over the horizon, ship to objective maneuver and activities of the ESG and Amphibious MAGTF for up to 10 days. The exercise utilizes all elements of the MAGTF to secure the battlespace (air, land, and sea), maneuver to and seize the objective, and conduct self-sustaining operations ashore with continual logistic support of the ESG. Tinian is the primary MIRC training area for this exercise; however elements of the exercise may be rehearsed nearshore and on Guam.

ASW active sonar activity may include: single and multi-unit TRACKEX and TORPEX in coordinated ASW event; active ASW sources may include SQS–53C/D; SQS–56; DICASS; IEER/AEER; AQS–22; BQQ–10; MK–48 EXTORP and Portable Underwater Tracking Range operation including transponders and MK–84 range tracking pingers.

Joint Multi-Strike Group Exercise—The Joint Multi-Strike Group conducts training involving Navy assets engaging in a schedule of events (SOE) battle scenario, with U.S. forces pitted against a notional opposition force (OPFOR). Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit.

The exercise includes several at-sea activities. In Command and Control (C2), a command organization exercises operational control of the assets involved in the exercise. This control includes monitoring for safety and compliance with protective measures. Air Warfare (AW) includes missile exercises which involve firing live missiles at air targets. Ships and aircraft fire missiles against air targets. AW also includes non-firing events such as Defensive Counter Air (DCA). DCA exercises ship and aircrew capabilities at detecting and reacting to incoming airborne threats. In Anti-Surface Warfare (ASUW), Naval forces control sea lanes by countering hostile surface combatant ships.

ASW active sonar activity in this exercise may include: Single and multi-unit TRACKEX and TORPEX in coordinated ASW events; active ASW sources may include SQS–53C/D; SQS–56; DICASS; IEER/AEER; AQS–22; BQQ–10; MK–48 EXTORP; Portable Underwater Tracking Range operation including transponders and MK–84 range tracking pingers.

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EXERCISE TYPE	SINKEX	EER/IEER	DEMO	BOMBEX [A-S]	GUNEX [S–S]	MISSILEX [A-S]	ASW TRACKEX / TORPEX/ OTHER	(Major Ex.) Joint Expedit.	(Major Ex.) MAGTF	MULTI-STRIKE GROUP**
Sources/Weapons/ Rounds	See SINKEX Ordnance Table	SSQ-110A (4.1 pound [lb] NEW)	10 lb NEW (Agat and Apra Harbor)	MK 82/83/84 Series General Purpose Bombs - GBU-38/32/31 JDAM	5 in gun 76 mm gun	HELLFIRE*	AN/SQS-53 MFA Sonar AN/SQS-56 MFA Sonar BQQ-10 Submarine Sonar AN/SSQ-62 DICASS Sonobuoy AN/SSQ-125 AEER Sonobuoy AN/ASQ-22Track Mode (Dipping Sonar) MK-48 Torpedo HFA Sonar PUTR: transponders and MK-84 tracking pinger	AN/SQS-53 MFA Sonar AN/SQS-56 MFA Sonar BQQ-10 Submarine Sonar AN/SSQ-62 DICASS Sonobuoy AN/SSQ-125 AEER Sonobuoy AN/ASQ-22Track Mode (Dipping Sonar) MK-48 Torpedo HFA Sonar		AN/SQS-53 MFA Sonar AN/SQS-56 MFA Sonar BQQ-10 Submarine Sonar AN/SSQ-62 DICASS Sonobuoy AN/SSQ-125 AEER Sonobuoy AN/ASQ-22 Track Mode (Dipping Sonar) MK-48 Torpedo HFA Sonar
Explosion in or on water	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Length of Exercise	4-8 hrs over 1-2 days	6 hours	Variable	Variable	1 to 2 hours	2 – 4 hours	8 hours reset for modeling	10 days	10 days	10 days (12 hours reset for modeling)
Detonations/hours/ rounds/sonobuoy or torpedo deployments, or helicopter sonar dips per exercise or year	See SINKEX Ordnance Table	106 deploy/yr (non SINKEX)	50/yr (10 lb)	Delivery of up to (1) bomb / quarter; up to 4 bombs / year	5" - 320 Rounds 76mm – 120 Rounds	2 HELLFIRE Missiles	SQS-53 (Search) = 368 hrs/yr SQS-53 (Kingfisher) = 0 hrs/yr SQS-56 = 64 hrs/yr BQQ-10 = 12 hrs/yr SSQ-62 DICASS = 172 Sonobuoys/yr AN/SSQ-125 AEER = 8 ASQ-22 Track Mode = 304 Dips/yr MK-48 Torpedo = 40 torpedoes/yr PUTR: 8 hours/exercise	Joint Expeditionary and MAGTF combined are same as Multi-strike Group Exercise		SQS-53 (Search) = 1,705 hrs/exercise SQS-53 Kingfisher = 0 hrs/exercise SQS -56 = 77 hrs/exercise BQQ-10 = 0 hrs/exercise SSQ-62 DICASS* = 1,282 Sonobuoys/exercise AN/SSQ-125 AEER = 98 ASQ-22 Track Mode = 288 Dips/exercise MK-48 Torpedo* 0 /exercise
Number Exercises per Year	2	N/A	N/A	4	5" – 8/yr 76mm– 4/yr	2	ASW TRACKEX: 66 ASW TORPEX: 17 PUTR: 35	1 (in non-multi-strike year)	4 (in non-multi-strike year)	1
Area Used	W-517; maritime areas > 50 nm from land, ATCAAs	General	Piti Floating Mine Neutralization Site, Outer Apra Harbor Deep Agat Bay Mine Neutralization	W-517, maritime areas > 12 nm from land	W-517, maritime areas > 12nm from land, > 3 nm for small arms	W-517 > 12 nm from land,	Maritime areas > 3 nm from land, W-517	General MIRC	General MIRC	General MIRC
Months of Yr	Year Round	Year	Year Round	Year Round	Year	Year Round	Year round	Summer	Summer	Summer

Table 2. Summary of exercises in MIRC Study Area

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Activities Utilizing Underwater Detonations

Underwater detonation activities can occur at various depths depending on the activity, but may also include activities with detonations at or just below the surface (such as SINKEX or gunnery exercise [GUNEX]). When the weapons hit the target, except for live torpedo shots, there is no explosion in the water, and so a ''hit'' is not modeled (i.e., the energy (either acoustic or pressure) from the hit is not expected to reach levels that would result in take of marine mammals). When a live weapon misses, it is modeled as exploding below the water surface at 1 ft (5-inch naval gunfire, 76-mm rounds), 2 meters (Maverick, Harpoon, MK–82, MK–83, MK–84), or 50 ft (MK–48 torpedo) as shown in Appendix A of the Navy's application (the depth is chosen to represent the worst case of the possible scenarios as related to potential marine mammals impacts). Exercises may utilize either live or inert ordnance of the types listed in Table 3. Additionally, successful hit rates are known to the Navy and are utilized in the effects modeling. Training events that involve explosives and underwater detonations occur throughout the year and are described below and summarized in Table 2.

Ordnance	Net Explosive Weight	TTS		Injury		Mortality	Exclusion Zone Used (m)
		182 SEL	23 psi	205 SEL	13 psi-ms	31 psi-ms	
5" Naval gunfire	9.54 lbs	235	275	18	44	24	548
76 mm Rounds	1.6 lbs	100	152	8	25	13	548
HELLFIRE	16.5 lbs	424	327	84	112	59	1852 (SINKEX), 1645 (MISSILEX)
HARM**	41.6	689	448	133	156	66	1852 (SINKEX), 1645 (MISSILEX)
Maverick	78.5 lbs	959	554	182	191	107	1852 (SINKEX), 1645 (MISSILEX)
SLAM**	164.3	1406	726	262	237	137	1852 (SINKEX), 1645 (MISSILEX)
Harpoon	448 lbs	1666	847	121	276	160	1852 (SINKEX), 1645 (MISSILEX)
GBU-12**	238	1712	832	315	262	153	1852 (SINKEX), 914 (BOMBEX)
GBU-10**	945	3626	1326	613	373	223	1852 (SINKEX), 914 (BOMBEX)
MK-84/83/82	945 lbs	2260	2260	426	426	213	1851 (SINKEX)
MK-48	851 lbs	2588	1198	228	762	442	1852 (SINKEX)
Demolition Charges	10 lbs	511	353	26	162	82	548
EER/IEER	5 lbs	331	280	17	155	75	914

Table 3. Representative ordnance used in MIRC Explosive Exercises for which take of marine mammals is anticipated. Table also indicates range to indicated threshold and size of Navy exclusion zone used in mitigation. **Units are meters.**

Sinking Exercise—In a SINKEX, a specially prepared, deactivated vessel is deliberately sunk using multiple weapons systems. The exercise provides training to ship and aircraft crews in delivering both live and inert ordnance on a real target. These target vessels are empty, cleaned, and environmentally-remediated ship hulk. A SINKEX target is towed to sea and set adrift at the SINKEX location. The duration of a SINKEX is unpredictable since it ends when the target sinks, sometimes immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. Typically, the exercise lasts for 4 to 8 hours over 1 to 2 days. SINKEXs occur only occasionally during MIRC exercises. Potential harassment would be from underwater detonation. SINKEX events have been conducted in the open ocean of the western Pacific and within the MIRC, in compliance with 40 CFR 229.2.

The Environmental Protection Agency (EPA) grants the Navy a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels ''for the purpose of sinking such vessels in ocean waters…'' (40 CFR 229.2). Subparagraph (a)(3) of this regulation states ''All such vessel sinkings shall be conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land.''

SINKEX events typically include at least one surface combatant (frigate, destroyer, or cruiser); one submarine; and numerous fixed-wing and rotary-wing aircraft. One surface ship will serve as a surveillance platform to ensure the hulk does not pose a hazard to navigation prior to and during the SINKEX. The weapons actually expended during a SINKEX can vary greatly. Table 1–2 in the Navy's application indicates the typical ordnance used in a SINKEX, which include HARPOON, HELLFIRE, and MAVERICK missiles, 5′ gunfire, MK–48 torpedoes, and underwater demolitions. This table reflects the planning for weapons, which may be expended during one SINKEX in the MIRC Study Area. This level of ordnance is expected for each of the SINKEX events in the Joint Multi-strike Group exercise. With the exception of the torpedo, which is designed to explode below the target hulk in the water column, the weapons deployed during a SINKEX are intended to strike the target hulk, and thus not explode within the water column.

Surface-to-Surface Gunnery Exercise—S–S GUNEX take place in the open ocean to provide gunnery practice for Navy and Coast Guard ship crews. GUNEX training activities conducted in the offshore study area involve stationary targets such as a MK–42 floating at-sea target (FAST) or a MK–58 marker (smoke) buoy. The gun systems employed against surface targets include the 5-inch, 76 millimeter (mm), 25-mm chain gun, 20-mm Close-in Weapon System (CIWS), and 50-caliber machine gun. Typical ordnance expenditure for a single GUNEX is a minimum of 21 rounds of 5-inch or 76-mm ammunition, and approximately 150 rounds of 25-mm or .50-caliber ammunition. Both live and inert training rounds are used. After impacting the water, the rounds and fragments sink to the bottom of the ocean. A GUNEX lasts approximately 1 to 2 hours, depending on target services and weather conditions. The live 5-inch and 76-mm rounds are considered in the underwater detonation modeling.

Air-to-Surface Gunnery Exercise (A–S GUNEX)—A–S GUNEX training activities are conducted by rotary-wing aircraft against stationary targets (Floating at-sea Target [FAST] and smoke buoy). Rotary-wing aircraft involved in this activity would include a single helicopter using either 7.62-mm or .50-caliber door-mounted machine guns. A typical GUNEX will last approximately one hour and involve the expenditure of approximately 400 rounds of 0.50-caliber or 7.62-mm ammunition. Due to their being inert and the small size of the rounds, they are not considered to have an underwater detonation impact.

Air-to-Surface Missile Exercise (A–S MISSILEX)—The A–S MISSILEX consists of the attacking platform releasing a forward-fired, guided weapon at the designated towed target. The exercise involves locating the target, then designating the target, usually with a laser. A–S MISSILEX training that does not involve the release of a live weapon can take place if the attacking platform is carrying a captive air training missile (CATM) simulating the weapon involved in the training. The CATM MISSILEX is identical to a live-fire exercise in every aspect except that a weapon is not released. The training requires a laser-safe range as the target is designated just as in a live-fire exercise. From 1 to 16 aircraft, carrying live, inert, or CATMs, or flying without ordnance (dry runs) are used during the exercise. At sea, seaborne powered targets (SEPTARs), Improved Surface Towed Targets (ISTTs), and decommissioned hulks are used as targets. A–S MISSILEX assets include helicopters and/or 1 to 16 fixed-wing aircraft with air-to-surface missiles and anti-radiation missiles (electromagnetic radiation source seeking missiles). Targets include SEPTARs, ISTTs, and excess ship hulks. When HELLFIRE Missiles are used the exercise is called a HELLFIRE MISSILEX. HELLFIRE MISSILEXs would occur 2 times per year in an area approximately 30–35 nm south of Apra Harbor in W–517. Potential harassment would be from underwater detonation.

Surface-to-Surface Missile Exercise (S–S MISSILEX)—S–S MISSILEX involves the attack of surface targets at sea by use of cruise missiles or other missile systems, usually by a single ship conducting training in the detection, classification, tracking and engagement of a surface target. S–S MISSILEXs always occur during a SINKEX. Engagement is usually with HARPOON missiles or Standard missiles in the surface-to-surface mode. Targets could include virtual targets or the SEPTAR or ship deployed surface target. S–S MISSILEX training is routinely conducted on individual ships with embedded training devices. A S–S MISSILEX could include 4 to 20 surface-to-surface missiles, SEPTARs, a weapons recovery boat, and a helicopter for environmental and photo evaluation. All missiles are equipped with instrumentation packages or a warhead. Surface-to-air missiles can also be used in a surface-to-surface mode. Each exercise typically lasts five hours. Future S–S MISSILEX could range from 4 to 35 hours. Potential harassment would be from underwater detonation.

Air-to-Surface Bombing Exercise—During an Air-to-Surface Bombing Exercise (BOMBEX A–S), fixed-wing aircraft deliver bombs against simulated surface maritime targets, typically a smoke float, with the goal of destroying or disabling enemy ships or boats. Typically, a flight of two aircraft will approach the target from an altitude of between 15,000 ft to less than 3,000 ft, and will adhere to designated ingress and egress routes. Typical bomb release altitude is below 3,000 ft and within a range of 1000 yards for unguided munitions, and above 15,000 ft and in excess of 10 nm for precision-guided munitions. In most training exercises, the aircrew drops inert training ordnance, such as the Bomb Dummy Unit (BDU–45) on a MK–58 smoke float used as the target. Some BOMBEXs include the use of the MK–84/GBU–31 JDAM, the largest bomb proposed for use. JDAM training would occur 4 times per year in W–517 and generally in the southern portion avoiding known fishing areas. The surface danger zone requires a 25 nm buffer around the aim point, so that all operations occur within W–517. Each BOMBEX A–S can take up to 4 hours to complete.

Mine Neutralization—Mine Neutralization involves the detection, identification, evaluation, rendering safe, and disposal of mines and unexploded ordnance (UXO) that constitutes a threat to ships or personnel. Mine neutralization training can be conducted by a variety of air, surface and undersea assets. Potential harassment would be from underwater detonation.

Tactics for neutralization of ground or bottom mines involve the diver placing a specific amount of explosives, which when detonated underwater at a specific distance from a mine results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by Fleet ships in open-ocean areas are detonated at the surface. In support of an expeditionary assault, divers and Navy marine mammal assets deploy in very shallow water depths (10 to 40 feet) to locate mines and obstructions. Divers are transported to the mines by boat or helicopter. Inert dummy mines are used in the exercises. The total net explosive weight used against each mine ranges from less than 1 pound to 20 pounds.

All demolition activities are conducted in accordance with Commander, Naval Surface Forces Pacific (COMNAVSURFPAC) Instruction 3120.8F, Procedures for Disposal of Explosives at Sea/Firing of Depth Charges and Other Underwater Ordnance (DoN 2003). Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices for tethered mines require ground mine explosive charges to be suspended 10 feet below the surface of the water.

EER–IEER AN/SSQ–110A—The Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) Systems are airborne ASW systems used in conducting ''large area'' searches for submarines. These systems are made up of airborne avionics ASW acoustic processing and sonobuoy types that are deployed in pairs. The IEER System's active sonobuoy component, the AN/SSQ–110A Sonobuoy, generates a sound similar to a ''sonar ping'' using a small explosive and the passive AN/SSQ–101A ADAR Sonobuoy ''listens'' for the return echo of the ''sonar ping'' that has been bounced off the surface of a submarine. These sonobuoys are designed to provide underwater acoustic data necessary for naval aircrews to quickly and accurately detect submerged submarines. The sonobuoy pairs are dropped from a fixed-wing aircraft into the ocean in a predetermined pattern with a few buoys covering a very large area. The AN/SSQ–110A Sonobuoy Series is an expendable and commandable sonobuoy. Upon command from the aircraft, the bottom payload is released to sink to a designated operating depth. A second command is required from the aircraft to cause the second payload to release and detonate the explosive to generate a ''ping''. There is only one detonation in the pattern of buoys at a time. Potential harassment would be from underwater detonations.

The AEER system (described in the sonar source section) will eventually replace use of the EER/IEER system and was analyzed for this proposed rule.

Vessel Movement

The operation and movement of vessels that is necessary to conduct the training described above is also analyzed here. Training exercises involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 10 days. During training, speeds vary and depend on the specific type of activity, although 10–14 knots is considered the typical speed. The Navy logs about 1,000 total vessel days within the MIRC Study Area during a typical year. Training activities are widely dispersed throughout the large OPAREA, which encompasses 501,873 nm^2 (1,299,851 km^2). Consequently, the density of Navy ships within the Study Area at any given time is low.

Research, Development, Testing, and Evaluation

The Services may conduct RDT&E, engineering, and fleet support for command, control, and communications systems and ocean surveillance in the MIRC. These activities may include ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles testing, unmanned aerial vehicle (UAV) tests, electronic combat (EC), and other DoD weapons testing.

RDT&E activities, if they have a potential for takes of marine mammals, will be reviewed to assure they are included within the parameters of existing sonar and explosive activities as modeled for this rule and the LOAs. As an example, if a new model of SQS 53 sonar were tested, as long as it's operating parameters are within the parameters modeled, an equal number of hours of SQS 53C use in training would be deducted to ensure that the total SQS 53C hours for the year (training plus RDT&E) remain within those described in the rule. The same would apply for explosives, overall NET explosive weights for similar munitions would be reviewed to assure compliance with existing rules.

Additional information on the Navy's proposed activities may be found in the LOA Application and the Navy's MIRC DEIS.

Description of Marine Mammals in the Area of the Specified Activities

Thirty-two marine mammal species or populations/stocks have confirmed or possible occurrence within the MIRC, including seven species of baleen whales (mysticetes), 22 species of toothed whales (odontocetes), two species of seal (pinnipeds), and the dugong (sirenian). Table 4 summarizes their abundance, Endangered Species Act (ESA) status, occurrence, and density in the area. Seven of the species are ESA-listed and considered depleted under the MMPA: Blue whale; fin whale; humpback whale; sei whale; sperm whale; North Pacific right whale; Hawaiian monk seal; and dugong. The dugong is managed by the U.S. Fish and Wildlife Service and will not be addressed further here.

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Common Name	Species Name	IUCN/ ESA/ MMPA Status	Occurrence		Density
			Summer July-Nov	Winter Dec-June	
Mysticetes					
Blue whale	*Balaenoptera musculus*	E, D, S	Rare	Rare	0.0001***
Fin whale	*Balaenoptera physalus*	E, D, S	Rare	Regular	0.0003***
Sei whale	*Balaenoptera borealis*	E, D, S	Rare	Regular	.00029*
Bryde's whale	*Balaenoptera edeni*		Regular	Regular	.00041*
Minke whale	*Balaenoptera acutorostrata*		Rare	Regular	.0003***
Humpback whale	*Megaptera novaeangliae*	E, D, S	Rare	Regular	.0069***
North Pacific right whale	*Eubalaena japonica*	E, D, S	Rare	Rare	n/a
Odontocetes					
Sperm whale	*Physeter macrocephalus*	E, D, S	Regular	Regular	.00123*
Blainville's beaked whale	*Mesoplodon densirostris*		Regular	Regular	.00117**
Bottlenose dolphin	*Tursiops truncatus*		Regular	Regular	.00021*
Cuvier's beaked whale	*Ziphius cavirostris*		Regular	Regular	.00621**
Dwarf sperm whale	*Kogia sima*		Regular	Regular	.00714**
False killer whale	*Pseudorca crassidens*		Regular	Regular	.00111*
Fraser's dolphin	*Lagenodelphis hosei*		Regular	Regular	.00417**
Ginkgo-tooth beaked whale	*Mesoplodon ginkgodens*		Rare	Rare	.0005***
Hubbs beaked whale	*Mesoplodon carlhubbsi*		Extra-limital	Extra-limital	n/a
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*		Extra-limital	Extra-limital	n/a
Killer whale offshore	*Orcinus orca*		Regular	Regular	.00014**
Longman's beaked whale	*Indopacetus pacificus*		Regular	Rare	.00041**
Melon-headed whale	*Peponocephala electra*		Regular	Regular	.00428*
Pantropical spotted dolphin	*Stenella attenuata*		Regular	Regular	.0226*
Pygmy killer whale	*Feresa attenuata*		Regular	Regular	.00014*
Pygmy sperm whale	*Kogia breviceps*		Regular	Regular	.00291**
Risso's dolphin	*Grampus griseus*		Regular	Regular	.00097**
Rough-toothed dolphin	*Steno bredanensis*		Regular	Regular	.00029*
Short-beaked common dolphin	*Delphinus delphis*		Rare	Rare	.0021***
Short-finned pilot whale	*Globicephala macrorhynchus*		Regular	Regular	.00159*
Spinner dolphin	*Stenella longirostris*		Regular	Regular	.00314*
Striped dolphin	*Stenella coeruleoalba*		Regular	Regular	.00616*
Pinniped					
Northern elephant seal	*Mirounga angustirostris*		Extra-limital	Extra-limital	n/a
Hawaiian Monk Seal	*Monachus schauinslandi*	T, D, S	Extra-limital	Extra-limital	n/a
Sirenia					
Dugong	*Dugong dugon*	E, V	Extra-limital	Extra-limital	n/a

Table 4. Marine Mammals of known or possible occurrence in MIRC. Table includes status, ocurrence, and density.

* Density derived from 2007 Mariana Islands Survey (MISTCS Report - DoN 2007)

**Density derived from Hawaii Offshore Report (Barlow 2006)

*** Density derived from Eastern Tropical Pacific (Ferguson and Barlow 2001, 2003)

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Species Not Considered Further

North Pacific right whale—The likelihood of a North Pacific right whale (Eubalaena japonica) occurring in the action area is extremely low. The North Pacific right whale population is the most endangered of the large whale species (Perry *et al.,* 1999) and, currently, there is no reliable population estimate for this species, although the population in the western North Pacific Ocean is considered to be very small, perhaps in the tens to low hundreds of animals. Despite many years of systematic aerial and ship-based surveys for marine mammals off the western coast of the U.S., only seven documented sightings of right whales were made from 1990 through 2005 near Alaska (Waite *et al.,* 2003; Wade *et al.,* 2006). Based on this information, it is highly unlikely for a right whale to be present in the action area. Consequently, this species will not be considered in the remainder of this analysis.

Hawaiian monk seal—The likelihood of a Hawaiian monk seal (Monachus schauinslandi) being present in the action area is extremely low. There are no confirmed records of Hawaiian monk seals in the Micronesia region; however, Reeves *et al.* (1999) and Eldredge (1991, 2003) have noted occurrence records for seals (unidentified species) in the Marshall and Gilbert islands. It is possible that Hawaiian monk seals wander from the Hawaiian Islands to appear at the Marshall or Gilbert Islands in the Micronesia region (Eldredge 1991). However, given the extremely low likelihood of this species occurrence in the action area, the Hawaiian monk seal will not be considered in the remainder of this analysis.

Hubbs Beaked Whale—The likelihood of a Hubbs beaked whale (Mesoplodon carlhubbsi) occurring in the action area is extremely low. There are no occurrence records for the Mariana Islands and the nearest records are from strandings in Japan (DoN 2005). Recent data suggests that the distribution is likely north of 30° N (MacCleod *et al.,* 2006). Given the extremely low likelihood of this species occurrence in the action area, the Hubbs beaked whale will not be considered in the remainder of this analysis.

Indo-Pacific Bottlenose Dolphin—The likelihood of an Indo-Pacific bottlenose dolphin (Tursiops aduncas) occurring in the action area is extremely low. The Indo-Pacific bottlenose dolphin is generally associated with continental margins and does not appear to occur around offshore islands that are great distances from a continent, such as the Marianas (Jefferson as cited in DoN 2005). Given the extremely low likelihood of this species occurrence in the action area, the Indo-Pacific bottlenose dolphin will not be considered in the remainder of this analysis.

Northern Elephant Seal—Northern elephant seals (Mirounga angustirostris) are common on islands and mainland haul-out sites in Baja California, Mexico north through central California. Elephant seals spend several months at sea feeding and travel as far as the Gulf of Alaska. Occasionally juveniles wander great distances with several individuals being observed in Hawaii and Japan. Although elephant seals may wander great distances it is very unlikely that they would travel to Japan or Hawaii and then continue traveling to the MIRC. Given the extremely low likelihood of this species occurrence in the action area, the northern elephant seal will not be considered in the remainder of this analysis.

The Navy has compiled information on the abundance, behavior, status and distribution, and vocalizations of marine mammal species in the MIRC waters from the Navy Marine Resource Assessment and has supplemented this information with additional citations derived from new survey efforts and scientific publications. NMFS has not designated stocks of marine mammals in the waters surrounding the MIRC and, therefore, does not compile stock assessment reports for this area. This information may be viewed in the Navy's LOA application and/or the Navy's DEIS for MIRC (see Availability), and is incorporated by reference herein.

There are no designated marine mammal critical habitats or known breeding areas within the MIRC. Much is unknown about the reproductive habits of the dolphin species in MIRC, but they are thought to mate throughout their range (like better studied species and stocks are known to do) and possibly throughout the year. Even less is known about the mating habits of beaked whales. Baleen whales and sperm whales are thought to breed seasonally in areas within and around the MIRC and some calves have been seen with sperm, Bryde's and sei whales (DoN 2007b), although it is not known where exactly breeding and calving occurs.

Spinner dolphins, which rest primarily during the day in relatively large groups, are known to consistently use certain areas (usually bays) for this function. Because of this, they are regularly visited by whalewatching boats or other members of the public interested in viewing or interacting with them, which could potentially put them at increased energetic risk if their resting cycles are repeatedly interrupted in a significant manner. There are several recognized resting areas for spinner dolphins in the MIRC Study Area: Agat Bay, Bile/Tougan Bay, and Double Reef. These areas are in clear, calm, shallow waters sheltered from prevailing tradewinds.

Marine Mammal Hearing and Vocalizations

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some changes to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into an outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by a tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear transmit airborne sound to the inner ear, where the sound waves are propagated through the cochlear fluid. Since the impedance of water is close to that of the tissues of a cetacean, the outer ear is not required to transduce sound energy as it does when sound waves travel from air to fluid (inner ear). Sound waves traveling through the inner ear cause the basilar membrane to vibrate. Specialized cells, called hair cells, respond to the vibration and produce nerve pulses that are transmitted to the central nervous system. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Pickles, 1998). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. Conversely, dolphins and porpoises have ears that are specialized to hear high frequencies.

Marine mammal vocalizations often extend both above and below the range of human hearing; vocalizations with frequencies lower than 18 Hertz (Hz) are labeled as infrasonic and those higher than 20 kHz as ultrasonic (National Research Council [NRC], 2003; Figure 4–1). Measured data on the hearing abilities of cetaceans are sparse, particularly for the larger cetaceans such as the baleen whales. The auditory thresholds of some of the smaller odontocetes have been determined in captivity. It is generally believed that cetaceans should at least be sensitive to the frequencies of their own vocalizations. Comparisons of the anatomy of cetacean inner ears and models of the structural properties and the response to vibrations of the ear's components in different species provide an indication of likely sensitivity to various sound frequencies. The ears of small toothed whales are optimized for receiving high-frequency sound, while baleen whale inner ears are best in low to infrasonic frequencies (Ketten, 1992; 1997; 1998).

Baleen whale vocalizations are composed primarily of frequencies below 1 kHz, and some contain fundamental frequencies as low as 16 Hz (Watkins *et al.,* 1987; Richardson *et al.,* 1995; Rivers, 1997; Moore *et al.,* 1998; Stafford *et al.,* 1999; Wartzok and Ketten, 1999) but can be as high as 24 kHz (humpback whale; Au *et al.,* 2006). Clark and Ellison (2004) suggested that baleen whales use low frequency sounds not only for long-range communication, but also as a simple form of echo ranging, using echoes to navigate and orient relative to physical features of the ocean. Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Although there is apparently much variation, the source levels of most baleen whale vocalizations lie in the range of 150–190 dB re 1 μPa at 1

m. Low-frequency vocalizations made by baleen whales and their corresponding auditory anatomy suggest that they have good low-frequency hearing (Ketten, 2000), although specific data on sensitivity, frequency or intensity discrimination, or localization abilities are lacking. Marine mammals, like all mammals, have typical U-shaped audiograms that begin with relatively low sensitivity (high threshold) at some specified low frequency with increased sensitivity (low threshold) to a species specific optimum followed by a generally steep rise at higher frequencies (high threshold) (Fay, 1988).

The toothed whales produce a wide variety of sounds, which include species-specific broadband ''clicks'' with peak energy between 10 and 200 kHz, individually variable ''burst pulse'' click trains, and constant frequency or frequency-modulated (FM) whistles ranging from 4 to 16 kHz (Wartzok and Ketten, 1999). The general consensus is that the tonal vocalizations (whistles) produced by toothed whales play an important role in maintaining contact between dispersed individuals, while broadband clicks are used during echolocation (Wartzok and Ketten, 1999). Burst pulses have also been strongly implicated in communication, with some scientists suggesting that they play an important role in agonistic encounters (McCowan and Reiss, 1995), while others have proposed that they represent ''emotive'' signals in a broader sense, possibly representing graded communication signals (Herzing, 1996). Sperm whales, however, are known to produce only clicks, which are used for both communication and echolocation (Whitehead, 2003). Most of the energy of toothed whales social vocalizations is concentrated near 10 kHz, with source levels for whistles as high as 100–180 dB re 1 μPa at 1 m (Richardson *et al.,* 1995). No odontocete has been shown audiometrically to have acute hearing (<80 dB re 1 μPa) below 500 Hz (DoN, 2001). Sperm whales produce clicks, which may be used to echolocate (Mullins *et al.,* 1988), with a frequency range from less than 100 Hz to 30 kHz and source levels up to 230 dB re 1 μPa 1 m or greater (Mohl *et al.,* 2000).

Table 5 includes a summary of the vocalizations of the species found in the MIRC. The ''Brief Background on Sound'' section below contains a description of the functional hearing groups designated by Southall *et al.* (2007), which includes the functional hearing range of various marine mammal groups (i.e., what frequencies that can actually hear).

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Species	Signal Type	Frequency Range (kHz)	Frequency Near Max Energy (kHz)	Source Level (dB re 1	Duration / Other
Blue whale	moans, long duration songs	0.012 - .4	.012 - .025	188	up to 36 s, repeated every 1 - 2 min
	FM sweeps	0.858 ± 0.148			<5 s
	vocalizations	0.012 - .4	.012 - .025		
Fin whale	vocalizations	- / .015 - .028	- / -	159-184 / 185-192	
	moans	0.016 - 0.75	0.02	160-190	
	pulses	0.04 - 0.075 / 0.018 - 0.025	- / 0.02		
	ragged pulse	< 0.03			
	rumbles	- / 0.01 - 0.03	< 0.03 / -		
	moans, downsweeps	0.014 - 0.118	0.02	160-186	
	constant call	0.02 - 0.04			
	moans, tones, upsweeps	0.03 - 0.75		155-165	
	whistles, chirps	1.5 - 5	1.5 - 2.5		
	clicks	16 - 28			
	vocal sequence, ? only	0.015 - 0.03			
	FM sweeps	0.018 - .23		184 - 186	1 s
Humpback whale	social	.020 - 10 / 0.05 -10	<3 / 0.1 - 4		
	songs	0.03 - 8 / -	0.12 - 4 / -	144 - 186 / 151-173	
	shrieks		0.75 - 1.8	179-181	
	horn blasts		0.41 - 0.42	181-185	
	moans	0.02 - 1.8	0.035 - 0.36	175	
	grunts	0.025 - 1.9		190	
	pulse trains	0.025 - 1.25	0.025 - 0.080	179-181	
	slap	0.03 - 1.2		183-192	
	feeding calls	0.02 - 2	0.5	162 -192	< 1 s
Calf	simple vocalization	0.14 - 4	0.22 (mean)		
Sei whale	FM sweeps	1.5 - 3.5			7 to 20 sweeps lasting 4 ms
	growls, whooshes, tonal calls	0.433		156	.45 s
	growls and whooshes	0.241 - 0.625		152.4 - 159.6	
Bryde's whale	moans	0.07 - 0.245	0.124 - 0.132	152-174	0.25 to several s
	pulsed moans	0.1 - 0.93	0.165 - 0.9		
	discrete pulses	0.7 - 0.95	0.7 - 0.9		
	call	< 0.06			0.25 to several s
Minke whale	sweeps, moans	0.06 - 0.14		151-175	
	down sweeps	0.06 - 0.13		165	
	moans, grunts	0.06 - 0.14	0.06 - 0.14	151-175	
	ratchet	0.85 - 6	0.85		
	thump trains	0.1 - 2	0.1 - 0.2		
	speed up pulse train	0.2 - 0.4			40 to 60 ms
	slow down pulse train	0.25 - 0.35			70 to 140 ms
	Star Wars vocalization	0.05 - 9.4		150-165	
	Breeding Boings (pulse then amp-mod. call)	1.3 - 1.4			2.5 s with slight frequency modulation
	vocalizations	0.06 - 12			

Table 5a. Summary of mysticete vocalization information compiled from The Biology of Marine Mammals (Reynolds and Rommel (eds), 1999) and the Navy's SOCAL, AFAST, HRC, and MIRC EISs - see those documents for specific information.

Species	Signal Type	Frequency Range (kHz)	Frequency Near Max energy (kHz)	Source Level (dB re	Duration / Other
Sperm whale	clicks	0.1 - 30	2 - 4, 10 - 16	160 - 180	< 30 ms
	short clicks			236	< 1 µs, highly directional
	trumpets			172	
Neonate	clicks		0.5	140 - 162	directionality
Blainville's beaked whale	whistles, chirps	< 1 - 6			
	whistles	2.6 - 10.7			
	echolocation clicks	20 - 40		200 - 220	m
Cuvier's beaked whale	echolocation clicks	20 - 40, 20 - 70		214	> 200 m
	whistles	8 - 12			upsweep lasts 1 s
	pulses	13 - 17			15 to 44 s
Ginkgo-toothed beaked whale					
Longman's beaked whale					
Bottlenose dolphin	whistles	0.8 - 24	3.5 - 14.5	125-173	
	whistle	4 - 20			
	click	0.2 - 150	30 - 60		
	click		110 - 130	218 - 228	
	clicks and burst-pulses	110 - 130		218 - 228	
	bark	0.2 - 16			
Fraser's dolphin	whistles	7.6 - 13.4			< 0.5 s
Pantropical spotted dolpin	whistles	3.1 - 21.4	6.7 - 17.8		
	pulse	up to 150			
	clicks	40 -140		up to 220	
Rough-toothed dolphin	whistles	0.3 - 24			< 1 s
	whistles		4 - 7		
	clicks	0.1 - 200	25		< 250 µsec
	clicks		5 - 32		
	echolocation clicks		50 -65	up to 222	< 40 - 70 µs
Risso's dolphin	whistles		3.5 - 4.5		
	rasp / pulse burst	0.1 - > 8	2 - 5		
	click		65	~120	
	whistle / burst	4 - 22			< 1 sec to several s
	broadband clicks	6 - > 22			
	narrowband grunts	0.4 - 0.8			
	echolocation clicks	30 - 50, 80 - 100		up to 216	
Common dolphin	whistles, chirps		0.5 - 18		
	whistles	4 - 16			
	click	0.2 - 150	30 - 60	170	
	clicks		23 - 67		
	chips and barks	0.5 - 14			
	whistles	2 - 18		180	
Spinner dolphin	pulse	1 - 160	5 - 60		
	whistles	1 - 20 / 1 - 22.5	8 - 12 / 6.8 - 17.9		
	echolocation clicks	up to 65			
	click	1 - 160	60	195 - 222	
Striped dolphin	whistles	1 - 22.5	6.8 - 16.9	109-125	
	whistles	6 - 24	8 - 12.5		
	pulse bursts	wideband	5 - 60	108-115	
Dwarf sperm whale	clicks	13-33			0.3 - 0.5 s
Pygmy sperm whale	clicks	60 - 200	120		
	narrowband pulses		129	175	40-70 ms
	echolocation clicks	60 - 200	120 - 130		
False killer whale	whistles		4 - 9.5		
	clicks		25 -30, 95 - 130	220-228	
	echolocation clicks	20 - 130	40	201 - 225	
Killer whale	whistles	1.5 - 18	6 - 12		
	clicks	0.1 - 35 / 0.25 - 0.5	12 - 25	180	
	scream	2			
	pulsed calls	0.5 - 25	1 - 6	160	
Canadian killer whale	echolocation clicks		45 - 80	195 - 224	< 80 - 120 µs
Norwegian killer whale	echolocation clicks		22 - 49	173 - 202	< 31 - 203 µs
Melon-headed whale	whistles	8 to 12		155	
	clicks	20 - 40		165	
Pygmy killer whale	clicks	45 - 117	70 - 85	197-223	
Short-finned pilot whale	whistles	0.5 - > 20	2 to 14	180	
	click		30 - 60	180	

Table 5b. Summary of odontocete and pinniped vocalization information compiled from The Biology of Marine Mammals (Reynolds and Rommel (eds), 1999) and the Navy's SOCAL, AFAST, HRC, and MIRC EISs - see those documents for specific information.

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Marine Mammal Density Estimates

Understanding the distribution and abundance of a particular marine mammal species or stock is necessary to analyze the potential impacts of an action on that species or stock. Further, it is necessary to know the density of the animals in the affected area in order to quantitatively assess the likely acoustic impacts of a potential action on individuals and estimate take (discussed further in the Estimated Take section).

Prior to 2007 there was little information available on the abundance and density of marine mammals in the MIRC Study Area. Most information on the occurrence of marine mammals came from short surveys (several days) and opportunistic sightings (NMFS Platform of Opportunity, oceanographic cruises or strandings). The first comprehensive survey of the area, Mariana Islands Sea Turtle and Cetacean Survey (MISTCS), was funded by the Navy to gather data in support of this analysis and was conducted in early 2007 covering mid January to mid April (DoN 2007b). Densities were calculated for 13 species observed during this survey and are the only published densities derived for this area that are based upon actual sightings. For the purposes of the MIRC analysis, the Navy compiled published densities from other geographical areas with existing survey data and similar oceanography (e.g. sea surface temperature) such as the Hawaiian Islands (Barlow 2003, 2006), warm water areas of the eastern tropical Pacific (Ferguson and Barlow 2001, 2003) and Miyashita (1993). As shown in Table 3–2 of the MIRC application, for the species that MISTCS provided an estimate for, the estimated densities are either mid-range or higher than the other published densities. This, combined with the fact that the MISTCS survey was conducted in the actual MIRC Study Area, supports the Navy's decision to use MISTCS data as the primary source for modeling. Considering the similar habitat and species diversity with the MIRC Study Area, offshore survey data from the Hawaiian Islands (Barlow 2003, 2006) was used as a secondary source. Densities from the Eastern Tropical Pacific survey (Ferguson and Barlow 2001, 2003) were used for six remaining species. Miyashita 1993 was also reviewed; however, no densities from that report were ultimately utilized because the surveys were not conducted in the systematic line transect manner typically used by NMFS, but rather occurred while searching for cetaceans.

The draft MISTCS density report was reviewed by local biologists at NMFS–Pacific Fisheries Science Center (PIFSC) and Pacific Islands Regional Office (PIRO), whose recommendations were incorporated into the final document. The methods used in the final MISTCS report was approved by NMFS PIFSC and PIRO for use in preparation of environmental planning documents for the Mariana Islands.

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 MFAS/HFAS 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 (μPa); for airborne sound, the standard reference pressure is 20 μPa (Richardson *et al.,* 1995).

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 μPa or, for airborne sound, 20 μPa). The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase over 10 dB, 30 dB is a 1,000-fold increase over 10dB). Humans perceive a 10-dB increase in noise as a doubling of loudness, or a 10 dB decrease in noise as a halving of loudness. 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 microPascal (denoted re: 1μPa) 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 63 dB quieter in air. Thus a sound that is 160 dB loud underwater would have the same approximate effective intensity as a sound that is 97 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 (typically below 20 Hz) and ultrasonic (typically above 20,000 Hz) 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''; explosives are an example of a broadband sound source and active 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 (AEP) techniques, anatomical modeling, and other data, Southall *et al.* (2007) designate ''functional hearing groups'' for marine mammals and estimate 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 (which are derived from the audiograms described above, see figure 1 in Southall *et al.* (2007) developed for each group. The functional groups and the associated frequencies are indicated below (though, again, animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- 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.

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 whale. When sound travels (propagates) away from its source, its loudness decreases as the distance traveled by the sound increases. 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 (in this example, it is spherical spreading). As a result, it is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean or its impacts on the marine environment.

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 MFAS/HFAS 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 micropascals (μPa), 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 μPa, and the units for SPLs are dB re: 1 μPa.

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 and 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 $\mu Pa^2 - s$.

SEL = SPL + 10log(duration in seconds)

As applied to MFAS/HFAS, 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. 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 at what received level the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in hearing are likely to occur are expressed in SEL.

Potential Effects of Specified Activities on Marine Mammals

The Navy has requested authorization for the take of marine mammals that may occur incidental to training and RDT&E activities in the MIRC utilizing MFAS/HFAS or underwater detonations. In addition to MFAS/HFAS and underwater detonations, the Navy has analyzed other potential impacts to marine mammals from training activities in the MIRC DEIS, including ship strike, aerial overflights, ship noise and movement, and others, and, in consultation with NMFS as a cooperating agency for the MIRC DEIS, has determined that take of marine mammals incidental to these non-acoustic components of the MIRC is unlikely and, therefore, has not requested authorization for take of marine mammals that might occur incidental to these non-acoustic components. In this document, NMFS analyzes the potential effects on marine mammals from exposure to MFAS/HFAS and underwater detonations, but also includes some additional analysis of the potential impacts from vessel operations in the MIRC.

For the purpose of MMPA authorizations, NMFS' effects assessments serve four primary purposes: (1) To help identify the permissible methods of taking, meaning: the nature of the take (e.g., resulting from anthropogenic noise vs. from ship strike, etc.); the regulatory level of take (i.e., mortality vs. Level A or Level B harassment); and, the amount of take; (2) to inform the prescription of means of effecting the least practicable adverse impact on such species or stock and its habitat (i.e., mitigation); (3) to support the determination of 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); and (4) 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 MIRC).

More specifically, for activities involving sonar or underwater detonations, NMFS' analysis will identify 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. In this section, we will focus qualitatively on the different ways that MFAS/HFAS and underwater explosive detonations may affect marine mammals (some of which NMFS would not classify as harassment). Then, in the Estimated Take of Marine Mammals Section, NMFS will relate the potential effects to marine mammals from MFAS/HFAS and underwater detonation of explosives to the MMPA regulatory definitions of Level A and Level B Harassment and attempt to quantify those effects.

Exposure to MFAS/HFAS

In the subsections below, the following types of impacts are discussed in more detail: direct physiological impacts, stress responses, acoustic masking and impaired communication, behavioral disturbance, and strandings. An additional useful graphic tool for better understanding the layered nature of potential marine mammal responses to anthropogenic sound is presented in Figure 1 of NMFS' August 13, 2009 biological opinion for SURTASS LFA (available at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*). That document presents a conceptual model of the potential responses of endangered and threatened species upon being exposed to active sonar and the pathways by which those responses might affect the fitness of individual animals that have been exposed, and the resulting impact on the individual animal's ability to reproduce or survive. Literature supporting the framework, with examples drawn from many taxa (both aquatic and terrestrial) was included in the ''Application of this Approach'' and ''Response Analyses'' sections of that document.

Direct Physiological Effects

Based on the literature, there are two basic ways that MFAS/HFAS 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 also occurs in a specific frequency range and amount as mentioned above for TTS.

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, along with the recovery time. Human non-impulsive noise exposure guidelines are based on exposures of equal energy (the same SEL) producing equal amounts of hearing impairment regardless of how the sound energy is distributed in time (NIOSH 1998). Until recently, previous marine mammal TTS studies have also generally supported this equal energy relationship (Southall *et al.,* 2007). Three newer studies, two by Mooney *et al.* (2009a, 2009b) on a single bottlenose dolphin either exposed to playbacks of Navy MFAS or octave-band noise (4–8 kHz) and one by Kastak *et al.* (2007) on a single California sea lion exposed to airborne octave-band noise (centered at 2.5 kHz), concluded that for all noise exposure situations the equal energy relationship may not be the best indicator to predict TTS onset levels. All three of these studies highlight the inherent complexity of predicting TTS onset in marine mammals, as well as the importance of considering exposure duration when assessing potential impacts. Generally, with sound exposures of equal energy, those that were quieter (lower sound pressure level [SPL]) with longer duration were found to induce TTS onset more than those of louder (higher SPL) and shorter duration (more similar to MFAS). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between intermittent 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/HFAS, 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 on the onset of TTS are limited to the captive bottlenose dolphin and beluga (Finneran *et al.,* 2000, 2002b, 2005a; Schlundt *et al.,* 2000; Nachtigall *et al.,* 2003, 2004). For pinnipeds in water, data are limited to Kastak *et al.'*s measurement of TTS in one harbor seal, one elephant seal, and one California sea lion.

Marine mammal hearing plays a critical role in communication with conspecifics and in interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (i.e., recovery time), 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 a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication. The fact that animals exposed to levels and durations of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature is also notable and potentially of more importance than the simple existence of a TTS.

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 than TTS because it is a permanent 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/HFAS 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) although recent preliminary empirical data suggests that there is no increase in blood nitrogen levels or formation of bubbles in diving bottlenose dolphins (Houser 2008). 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 MFAS pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. 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) 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. Alternatively, Tyack *et al.* (2006) studied the deep diving behavior of beaked whales and concluded that ''Using current models of breath-hold diving, we infer that their natural diving behavior is inconsistent with known problems of acute nitrogen supersaturation and embolism.'' 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; Cox *et al.,* 2006; Rommel *et al.,* 2006). 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 (Rommel *et al.,* 2006). 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 MFAS/HFAS 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/HFAS 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 as, 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.* (1995b) 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 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). A recent study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

As mentioned previously, the functional hearing ranges of odontocetes, pinnipeds underwater, and mysticetes all overlap the frequencies of the MFAS/HFAS sources used in the Navy's MFAS/HFAS training exercises (although some mysticete's best hearing capacities are likely at frequencies somewhat lower than MFAS). Additionally, in almost all species, vocal repertoires span across the frequencies of these MFAS/HFAS 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. For hull-mounted MFAS/HFAS, which accounts for the largest part of the takes of marine mammals (because of the source strength and number of hours it's conducted), the pulse length and duty cycle of the MFAS/HFAS signal (~ 1 second pulse twice a minute) makes it less likely that masking will occur as a result.

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 they drop 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 is more important than simply detecting that a vocalization is occurring (Brenowitz, 1982; Brumm *et al.,* 2004; Dooling, 2004, Marten and Marler, 1977; Patricelli *et al.,* 2006). Most animals that vocalize have evolved with an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability/distinguishability of their vocalizations in the face of temporary changes in background noise (Brumm *et al.,* 2004; Patricelli *et al.,* 2006). Vocalizing animals can 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 sympathetic part of 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 effect 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; see 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 impairs 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. Note that these examples involved a long term (days or weeks) stress response exposure to a stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; 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 high frequency, 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 (i.e., goldfish) 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 marine mammals 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 marine mammals 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), NMFS also assumes that stress responses could 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. Many different variables can influence an animal's perception of and response to (in both nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source 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.

Exposure of marine mammals to sound sources can result in (but is not limited to) no response or any of 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; avoidance; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.,* 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). A more recent review (Nowacek *et al.,* 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sub-sections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

Alteration of Diving or Movement—Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek *et al.* (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, a reaction, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa *et al.,* 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the varied nature of behavioral effects and consequent difficulty in defining and predicting them.

Foraging—Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western grey whales off the coast of Russia (Yazvenko *et al.,* 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen *et al.,* 2006). Balaenopterid whales exposed to moderate SURTASS LFA demonstrated no variation in foraging activity (Croll *et al.,* 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek *et al.,* 2004). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Brownell (2004) reported the behavioral responses of western gray whales off the northeast coast of Sakhalin Island to sounds produced by seismic activities in that region. In 1997, the gray whales responded to seismic activities by changing their swimming speed and orientation, respiration rates, and distribution in waters around the seismic surveys. In 2001, seismic activities were conducted in a known feeding area of these whales and the whales left the feeding area and moved to areas farther south in the Sea of Okhotsk. They only returned to the feeding area several days after the seismic activities stopped. The potential fitness consequences of displacing these whales, especially mother-calf pairs and ''skinny whales,'' outside of their normal feeding area is not known; however, because gray whales, like other large whales, must gain enough energy during the summer foraging season to last them the entire year, sounds or other stimuli that cause them to abandon a foraging area for several days could disrupt their energetics and force them to make trade-offs like delaying their migration south, delaying reproduction, reducing growth, or migrating with reduced energy reserves.

Social relationships—Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Sperm whales responded to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins *et al.,* 1985). In contrast, sperm whales in the Mediterranean that were exposed to submarine sonar continued calling (J. Gordon pers. Comm. cited in Richardson *et al.,* 1995). Social disruptions must be considered, however, in context of the relationships that are affected. While some disruptions may not have deleterious effects, long-term or repeated disruptions of mother/calf pairs or interruption of mating behaviors have the potential to affect the growth and survival or reproductive effort/success of individuals, respectively.

Vocalizations (also see Masking Section)—Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their ''songs'' (Miller *et al.,* 2000; Fristrup *et al.,* 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.,* 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote *et al.,* 2004). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles *et al.,* 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Avoidance—Avoidance is the displacement of an individual from an area as a result of the presence of a sound. Richardson *et al.* (1995) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. It is qualitatively different from the flight response, but also differs in the magnitude of the response (i.e., directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. Longer term displacement is possible, however, which can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the chronic sound (Blackwell *et al.,* 2004; Bejder *et al.,* 2006; Teilmann *et al.,* 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein *et al.,* 2001; Finneran *et al.,* 2003; Kastelein *et al.,* 2006a; Kastelein *et al.,* 2006b). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents have also been noted in wild populations of odontocetes (Bowles *et al.,* 1994; Goold, 1996; 1998; Stone *et al.,* 2000; Morton and Symonds, 2002) and to some extent in mysticetes (Gailey *et al.,* 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell *et al.,* 2007; Miksis-Olds *et al.,* 2007).

Maybaum (1993) conducted sound playback experiments to assess the effects of mid-frequency active sonar on humpback whales in Hawaiian waters. Specifically, she exposed focal pods to sounds of a 3.3-kHz sonar pulse, a sonar frequency sweep from 3.1 to 3.6 kHz, and a control (blank) tape while monitoring the behavior, movement, and underwater vocalizations. The two types of sonar signals (which both contained both mid- and low frequency components) differed in their effects on the humpback whales, but both resulted in avoidance behavior. The whales responded to the pulse by increasing their distance from the sound source and responded to the frequency sweep by increasing their swimming speeds and track linearity. In the Caribbean, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range of 1000 Hz to 10,000 Hz (IWC 2005).

Kvadsheim *et al.,* (2007) conducted a controlled exposure experiment in which killer whales (*Orcinus orca*) that had been fitted with D-tags were exposed to mid-frequency active sonar (Source A: a 1.0 s upsweep 209 dB @ 1–2 kHz every 10 seconds for 10 minutes; Source B: with a 1.0 s upsweep 197 dB @ 6–7 kHz every 10 s for 10 min). When exposed to Source A, a tagged whale and the group it was traveling with did not appear to avoid the source. When exposed to Source B, the tagged whales along with other whales that had been carousel feeding, ceased feeding during the approach of the sonar and moved rapidly away from the source. When exposed to Source B, Kvadsheim and his co-workers reported that a tagged killer whale seemed to try to avoid further exposure to the sound field by immediately swimming away (horizontally) from the source of the sound; by engaging in a series of erratic and frequently deep dives that seem to take it below the sound field; or by swimming away while engaged in a series of erratic and frequently deep dives. Although the sample sizes in this study are too small to support statistical analysis, the behavioral responses of the orcas were consistent with the results of other studies.

In 2007, the first in the series of behavioral response studies conducted by NMFS and other scientists showed one beaked whale (*Mesoplodon densirostris*) responding to an MFAS playback. The BRS–07 Cruise report indicates that the playback began when the tagged beaked whale was vocalizing at depth (at the deepest part of a typical feeding dive), following a previous control with no sound exposure. The whale appeared to stop clicking significantly earlier than usual, when exposed to mid-frequency signals in the 130–140 dB (rms) received level range. After a few more minutes of the playback, when the received level reached a maximum of 140–150 dB, the whale ascended on the slow side of normal ascent rates with a longer than normal ascent, at which point the exposure was terminated. The BRS–07 Cruise report notes that the results are from a single experiment and that a greater sample size is needed before robust and definitive conclusions can be drawn (NMFS, 2008). The BRS–08 Cruise report has not been published yet.

Flight Response—A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presences of predators have occurred (Connor and Heithaus, 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with MFAS activities (Evans and England, 2001). If marine mammals respond to Navy vessels that are 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 avoidance and flight responses should also increase as received levels of active sonar increase (and the ship is, therefore, closer) and as ship speeds increase (that is, as approach speeds increase). For example, the probability of flight responses in Dall's sheep *Ovis dalli dalli* (Frid 2001a, 2001b), ringed seals *Phoca hispida* (Born *et al.,* 1999), Pacific brant (*Branta bernicl 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).

Breathing—Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey *et al.,* 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein *et al.,* 2001; Kastelein *et al.,* 2006a) and emissions for underwater data transmission (Kastelein *et al.,* 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein *et al.,* 2006a), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Continued Pre-disturbance Behavior and Habituation—Under some circumstances, some of the individual marine mammals that are exposed to active sonar transmissions will continue their normal behavioral activities; in other circumstances, individual animals will become aware of the sonar transmissions at lower received levels and move to avoid additional exposure or exposures at higher received levels (Richardson *et al.,* 1995).

It is difficult to distinguish between animals that continue their pre-disturbance behavior without stress responses, animals that continue their behavior but experience stress responses (that is, animals that cope with disturbance), and animals that habituate to disturbance (that is, they may have experienced low-level stress responses initially, but those responses abated over time). Watkins (1986) reviewed data on the behavioral reactions of fin, humpback, right and minke whales that were exposed to continuous, broadband low-frequency shipping and industrial noise in Cape Cod Bay. He concluded that underwater sound was the primary cause of behavioral reactions in these species of whales and that the whales responded behaviorally to acoustic stimuli within their respective hearing ranges. Watkins also noted that whales showed the strongest behavioral reactions to sounds in the 15 Hz to 28 kHz range, although negative reactions (avoidance, interruptions in vocalizations, etc.) were generally associated with sounds that were either unexpected, too loud, suddenly louder or different, or perceived as being associated with a potential threat (such as an approaching ship on a collision course). In particular, whales seemed to react negatively when they were within 100 m of the source or when received levels increased suddenly in excess of 12 dB relative to ambient sounds. At other times, the whales ignored the source of the signal and all four species habituated to these sounds.

Nevertheless, Watkins concluded that whales ignored most sounds in the background of ambient noise, including the sounds from distant human activities even though these sounds may have had considerable energies at frequencies well within the whales' range of hearing. Further, he noted that of the whales observed, fin whales were the most sensitive of the four species, followed by humpback whales; right whales were the least likely to be disturbed and generally did not react to low-amplitude engine noise. By the end of his period of study, Watkins (1986) concluded that fin and humpback whales have generally habituated to the continuous and broadband noise of Cape Cod Bay while right whales did not appear to change their response. As mentioned above, animals that habituate to a particular disturbance may have experienced low-level stress responses initially, but those responses abated over time. In most cases, this likely means a lessened immediate potential effect from a disturbance; however, concern exists where the habituation occurs in a potentially more harmful situation, for example: animals may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.,* 1993; Wiley *et al.,* 1995).

Aicken *et al.,* (2005) monitored the behavioral responses of marine mammals to a new low-frequency active sonar system that was being developed for use by the British Navy. During those trials, fin whales, sperm whales, Sowerby's beaked whales, long-finned pilot whales (*Globicephala melas*), Atlantic white-sided dolphins, and common bottlenose dolphins were observed and their vocalizations were recorded. These monitoring studies detected no evidence of behavioral responses that the investigators could attribute to exposure to the low-frequency active sonar during these trials.

Behavioral Responses (Southall et al. (2007))

Southall *et al.* (2007) reports the results of the efforts of a panel 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 human-made sound with the goal of proposing exposure criteria for certain effects. This peer-reviewed compilation of literature is very valuable, though Southall *et al.* (2007) note that not all data are 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. All of the studies considered, however, contain an estimate of the received sound level when the animal exhibited the indicated response.

In the Southall *et al.* (2007) publication, 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. MFAS/HFAS is considered a non-pulse sound. Southall *et al.* (2007) summarize the studies associated with low-frequency, mid-frequency, and high-frequency cetacean and pinniped responses to non-pulse sounds, based strictly on received level, in Appendix C of their article (incorporated by reference and summarized in the three paragraphs below).

The studies 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 MFAS/HFAS) including: vessel noise, drilling and machinery playback, low-frequency M-sequences (sine wave with multiple phase reversals) playback, tactical low-frequency active sonar playback, drill ships, Acoustic Thermometry of Ocean Climate (ATOC) source, and non-pulse playbacks. These studies generally indicate no (or very limited) responses to received levels in the 90 to 120 dB re: 1 μPa range and an increasing likelihood of avoidance and other behavioral effects in the 120 to 160 dB range. As mentioned earlier, though, 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 studies 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 MFAS/HFAS) including: pingers, drilling playbacks, ship and ice-breaking noise, vessel noise, Acoustic Harassment Devices (AHDs), Acoustic Deterrent Devices (ADDs), MFAS, and non-pulse bands and tones. Southall *et al.* (2007) were unable to come to a clear conclusion regarding the results of these studies. 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 typically responded at lower levels in the field).

The studies that address 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 MFAS/HFAS) including: pingers, AHDs, and various laboratory non-pulse sounds. All of these data were collected from harbor porpoises. Southall *et al.* (2007) concluded that the existing data indicate that harbor porpoises are likely sensitive to a wide range of anthropogenic sounds at low received levels (~90–120 dB), at least for initial exposures. All recorded exposures above 140 dB induced profound and sustained avoidance behavior in wild harbor porpoises (Southall *et al.*, 2007). Rapid habituation was noted in some but not all studies. There is no data to indicate whether other high frequency cetaceans are as sensitive to anthropogenic sound as harbor porpoises are.

The studies that address the responses of pinnipeds in water 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 MFAS/HFAS) including: AHDs, ATOC, various non-pulse sounds used in underwater data communication; underwater drilling, and construction noise. Few studies exist with enough information to include them in the analysis. The limited data suggested that exposures to non-pulse sounds between 90 and 140 dB generally do not result in strong behavioral responses in pinnipeds in water, but no data exist at higher received levels.

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 is not limited to: extensive or 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 6 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 pinnipeds in water to non-pulse sounds. This table is included simply to summarize the findings of the studies and opportunistic observations (all of which were capable of estimating received level) that Southall *et al.* (2007) compiled in the effort to develop acoustic criteria.

	Received RMS Sound Pressure Level (dB re: 1 μPa)											
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/P/H	L/M/H	L/M/H	L	L/H	H	M/H	M		
5			H	H	M							
4				L/M	L/M/P	P	L					
3		M	L/M	L/M	M/P	P						
2			L	L/M	L	L	L					
1			M	M	M							
0	L/H/P	L/H/P	L/M/H	L/M/H/P	L/M/H/P	L	M				M	M

Table 6. Data compiled from three tables from Southall et al. (2007) indicating when marine mammals (low-frequency cetaceans = L, mid-frequency cetaceans = M, high frequency cetaceans = H, and pinnipeds = P) 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.

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 are little quantitative marine mammal data relating the exposure of marine mammals to sound to effects on reproduction or survival, though data exist for terrestrial species to which we can draw comparisons for marine mammals. Several authors have reported that disturbance stimuli cause animals to abandon nesting and foraging sites (Sutherland and Crockford, 1993), cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan *et al.*, 1996, Feare 1976, Giese 1996, Mullner *et al.*, 2004, Waunters *et al.*, 1997), or cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill, 2002). Each of these studies addressed the consequences that result when animals shift from one behavioral state (for example, resting or foraging) to another behavioral state (avoidance or escape behavior) because of human disturbance or disturbance stimuli.

One consequence of behavioral avoidance results from changing the energetics of marine mammals because of the energy required to avoid surface vessels or the sound field associated with active sonar (Frid and Dill, 2002). Most animals can avoid that energetic cost by swimming away at slow speeds or those speeds that are at or near the minimum cost of transport (Miksis-Olds, 2006), as has been demonstrated in Florida manatees (Hartman, 1979, Miksis-Olds, 2006).

Those costs increase, however, when animals shift from a resting state, which is designed to conserve an animal's energy, to an active state that consumes energy the animal would have conserved had it not been disturbed. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting behavioral states to active behavioral states, which would imply that they incur an energy cost. Morete *et al.*, (2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling) and rolling interspersed with dives. When vessels approached, the amount of time cows and calves spent resting and milling, respectively declined significantly. These results are similar to those reported by Scheidat *et al.* (2004) for the humpback whales they observed off the coast of Ecuador.

Constantine and Brunton (2001) reported that bottlenose dolphins in the Bay of Islands, New Zealand only engaged in resting behavior 5% of the time when vessels were within 300 meters compared with 83% of the time when vessels were not present. Miksis-Olds (2006) and Miksis-Olds *et al*. (2005) reported that Florida manatees in Sarasota Bay, Florida, reduced the amount of time they spent milling and increased the amount of time they spent feeding when background noise levels increased. Although the acute costs of these changes in behavior are not likely to exceed an animal's ability to compensate, the chronic costs of these behavioral shifts are uncertain.

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 (usually 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 a 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 to 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% reproductive success rate 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% reproductive success rate. 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 jet-fights (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 (50.2×10^3 kJ/min), and spent energy fleeing or acting aggressively toward hikers (White *et al*., 1999). Alternately, Ridgway *et al*., (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five day period did not cause any sleep deprivation or stress effects such as changes in cortisol or epinephrine levels.

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hr cycle). 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; National Marine Fisheries Service, 2007p). 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 strandings 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 another phenomenon. 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 in an attempt to identify relationships between those stranding events and military active 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 (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 coincident with the use of MFAS, one of those seven had been associated with the use of tactical 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 (Franzis, 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 exercises involving the use of MFAS.

Strandings Associated With MFAS

Over the past 12 years, there have been five stranding events coincident with military mid-frequency active sonar use in which exposure to sonar is believed by NMFS and the Navy to have been a contributing factor: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006). Additionally, in 2004, during the RIMPAC exercises, between 150–200 usually pelagic melon-headed whales occupied the shallow waters of the Hanalei Bay, Kaua'i, Hawaii for over 28 hours. NMFS determined that the mid-frequency sonar was a plausible, if not likely, contributing factor in what may have been a confluence of events that led to the Hanalei Bay stranding. A number of other stranding events coincident with the operation of MFAS including the death of beaked whales or other species (Minke whales, dwarf sperm whales, pilot whales) have been reported; however, the majority have not been investigated to the degree necessary to determine the cause of the stranding and only one of these exercises was conducted by the U.S. Navy.

Greece (1996)

Twelve Cuvier's beaked whales stranded atypically (in both time and space) along a 38.2-kilometer strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting active sonar tests with signals of 600 Hz and 3 kHz and source levels of 228 and 226 dB re: 1μPa, respectively (D'Amico and Verboom, 1998; D'Spain *et al.*, 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998).

Necropsies of eight of the animals were performed but were limited to basic external examination and sampling of stomach contents, blood, and skin. No ears or organs were collected, and no histological samples were preserved. No apparent abnormalities or wounds were found (Frantzis, 2004). Examination of photos of the animals, taken soon after their death, revealed that the eyes of at least four of the individuals were bleeding. Photos were taken soon after their death (Frantzis, 2004). Stomach contents contained the flesh of cephalopods, indicating that feeding had recently taken place (Frantzis, 1998).

All available information regarding the conditions associated with this stranding event were compiled, and many potential causes were examined including major pollution events, prominent tectonic activity, unusual physical or meteorological events, magnetic anomalies, epizootics, and conventional military activities (International Council for the Exploration of the Sea, 2005a). However, none of these potential causes coincided in time or space with the mass stranding, or could explain its characteristics (International Council for the Exploration of the Sea, 2005a). The robust condition of the animals, plus the recent stomach contents, is inconsistent with pathogenic causes (Frantzis, 2004). In addition, environmental causes can be ruled out as there were no unusual environmental circumstances or events before or during this time period and within the general proximity (Frantzis, 2004).

Because of the rarity of this mass stranding of Cuvier's beaked whales in the Kyparissiakos Gulf (first one in history), the probability for the two events (the military exercises and the strandings) to coincide in time and location, while being independent of each other, was thought to be extremely low (Frantzis, 1998). However, because full necropsies had not been conducted, and no abnormalities were noted, the cause of the strandings could not be precisely determined (Cox *et al.*, 2006). A Bioacoustics Panel convened by NATO concluded that the evidence available did not allow them to accept or reject sonar exposures as a causal agent in these stranding events. Their official finding was ''An acoustic link can neither be clearly established, nor eliminated as a direct or indirect cause for the May 1996 strandings.'' The analysis of this stranding event provided support for, but no clear evidence for, the cause-and-effect relationship of active sonar training activities and beaked whale strandings (Cox *et al.*, 2006).

Bahamas (2000)

NMFS and the Navy prepared a joint report addressing the multi-species stranding in the Bahamas in 2000, which took place within 24 hours of U.S. Navy ships using MFAS as they passed through the Northeast and Northwest Providence Channels on March 15–16, 2000. The ships, which operated both AN/SQS–53C and AN/SQS–56, moved through the channel while emitting MFAS pings approximately every 24 seconds. Of the 17 cetaceans that stranded over a 36-hr period (Cuvier's beaked whales, Blainville's beaked whales, Minke whales, and a spotted dolphin), seven animals died on the beach (5 Cuvier's beaked whales, 1 Blainville's beaked whale, and the spotted dolphin), while the other 10 were returned to the water alive (though their ultimate fate is unknown). As discussed in the Bahamas report (DOC/DON, 2001), there is no likely association between the Minke whale and spotted dolphin strandings and the operation of MFAS.

Necropsies were performed on five of the stranded beaked whales. All five necropsied beaked whales were in good body condition, showing no signs of infection, disease, ship strike, blunt trauma, or fishery related injuries, and three still had food remains in their stomachs. Auditory structural damage was discovered in four of the whales, specifically bloody effusions or hemorrhaging around the ears. Bilateral intracochlear and unilateral temporal region subarachnoid hemorrhage, with blood clots in the lateral ventricles, were found in two of the whales. Three of the whales had small hemorrhages in their acoustic fats (located along the jaw and in the melon).

A comprehensive investigation was conducted and all possible causes of the stranding event were considered, whether they seemed likely at the outset or not. Based on the way in which the strandings coincided with ongoing naval activity involving tactical MFAS use, in terms of both time and geography, the nature of the physiological effects experienced by the dead animals, and the absence of any other acoustic sources, the investigation team concluded that MFAS aboard U.S. Navy ships that were in use during the active sonar exercise in question were the most plausible source of this acoustic or impulse trauma to beaked whales. This sound source was active in a complex environment that included the presence of a surface duct, unusual and steep bathymetry, a constricted channel with limited egress, intensive use of multiple, active sonar units over an extended period of time, and the presence of beaked whales that appear to be sensitive to the frequencies produced by these active sonars. The investigation team concluded that the cause of this stranding event was the confluence of the Navy MFAS and these contributory factors working together, and further recommended that the Navy avoid operating MFAS in situations where these five factors would be likely to occur. This report does not conclude that all five of these factors must be present for a stranding to occur, nor that beaked whales are the only species that could potentially be affected by the confluence of the other factors. Based on this, NMFS believes that the operation of MFAS in situations where surface ducts exist, or in marine environments defined by steep bathymetry and/or constricted channels may increase the likelihood of producing a sound field with the potential to cause cetaceans (especially beaked whales) to strand, and therefore, suggests the need for increased vigilance while operating MFAS in these areas, especially when beaked whales (or potentially other deep divers) are likely present.

Madeira, Spain (2000)

From May 10–14, 2000, three Cuvier's beaked whales were found atypically stranded on two islands in the Madeira archipelago, Portugal (Cox *et al.*, 2006). A fourth animal was reported floating in the Madeiran waters by fishermen but did not come ashore (Woods Hole Oceanographic Institution, 2005). Joint NATO amphibious training peacekeeping exercises involving participants from 17 countries aboard 80 warships, took place in Portugal during May 2–15, 2000.

The bodies of the three stranded whales were examined post mortem (Woods Hole Oceanographic Institution, 2005), though only one of the stranded whales was fresh enough (24 hours after stranding) to be necropsied (Cox *et al.*, 2006). Results from the necropsy revealed evidence of hemorrhage and congestion in the right lung and both kidneys (Cox *et al.*, 2006). There was also evidence of intercochlear and intracranial hemorrhage similar to that which was observed in the whales that stranded in the Bahamas event (Cox *et al.*, 2006). There were no signs of blunt trauma, and no major fractures (Woods Hole Oceanographic Institution, 2005). The cranial sinuses and airways were found to be clear with little or no fluid deposition, which may indicate good preservation of tissues (Woods Hole Oceanographic Institution, 2005).

Several observations on the Madeira stranded beaked whales, such as the pattern of injury to the auditory system, are the same as those observed in the Bahamas strandings. Blood in and around the eyes, kidney lesions, pleural hemorrhages, and congestion in the lungs are particularly consistent with the pathologies from the whales stranded in the Bahamas, and are consistent with stress and pressure related trauma. The similarities in pathology and stranding patterns between these two events suggest that a similar pressure event may have precipitated or contributed to the strandings at both sites (Woods Hole Oceanographic Institution, 2005).

Even though no definitive causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004): Exercises were conducted in areas of at least 547 fathoms (1000 m) depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 (1000–6000 m) fathoms occurring across a relatively short horizontal distance (Freitas, 2004); multiple ships were operating around Madeira, though it is not known if MFAS was used, and the specifics of the sound sources used are unknown (Cox *et al.*, 2006, Freitas, 2004); exercises took place in an area surrounded by land masses separated by less than 35 nm (65 km) and at least 10 nm (19 km) in length, or in an embayment. Exercises involving multiple ships employing MFAS near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

Canary Islands, Spain (2002)

The southeastern area within the Canary Islands is well known for aggregations of beaked whales due to its ocean depths of greater than 547 fathoms (1000 m) within a few hundred meters of the coastline (Fernandez *et al.*, 2005). On September 24, 2002, 14 beaked whales were found stranded on Fuerteventura and Lanzarote Islands in the Canary Islands (International Council for Exploration of the Sea, 2005a). Seven whales died, while the remaining seven live whales were returned to deeper waters (Fernandez *et al.*, 2005). Four beaked whales were found stranded dead over the next 3 days either on the coast or floating offshore. These strandings occurred within near proximity of an international naval exercise that utilized MFAS and involved numerous surface warships and several submarines. Strandings began about 4 hours after the onset of MFAS activity (International Council for Exploration of the Sea, 2005a; Fernandez *et al.*, 2005).

Eight Cuvier's beaked whales, one Blainville's beaked whale, and one Gervais' beaked whale were necropsied, six of them within 12 hours of stranding (Fernandez *et al.*, 2005). No pathogenic bacteria were isolated from the carcasses (Jepson *et al.*, 2003). The animals displayed severe vascular congestion and hemorrhage especially around the tissues in the jaw, ears, brain, and kidneys, displaying marked disseminated microvascular hemorrhages associated with widespread fat emboli (Jepson *et al.*, 2003; International Council for Exploration of the Sea, 2005a). Several organs contained intravascular bubbles, although definitive evidence of gas embolism in vivo is difficult to determine after death (Jepson *et al.*, 2003). The livers of the necropsied animals were the most consistently affected organ, which contained macroscopic gas-filled cavities and had variable degrees of fibrotic encapsulation. In some animals, cavitary lesions had extensively replaced the normal tissue (Jepson *et al.*, 2003). Stomachs contained a large amount of fresh and undigested contents, suggesting a rapid onset of disease and death (Fernandez *et al.*, 2005). Head and neck lymph nodes were enlarged and congested, and parasites were found in the kidneys of all animals (Fernandez *et al.*, 2005).

The association of NATO MFAS use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with active sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson *et al.*, 2003; Fernández *et al.*, 2005).

Spain (2006)

The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26, 2006, on the southeast coast of Spain, near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. The fourth animal was found dead on the afternoon of January 27, a few kilometers north of the first three animals. From January 25–26, 2006, Standing North Atlantic Treaty Organization (NATO) Response Force Maritime Group Two (five of seven ships including one U.S. ship under NATO Operational Control) had conducted active sonar training against a Spanish submarine within 50 nm (93 km) of the stranding site.

Veterinary pathologists necropsied the two male and two female Cuvier's beaked whales. According to the pathologists, the most likely primary cause of this type of beaked whale mass stranding event was anthropogenic acoustic activities, most probably anti-submarine MFAS used during the military naval exercises. However, no positive acoustic link was established as a direct cause of the stranding. Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004); exercises were conducted in areas of at least 547 fathoms (1000 m) depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 fathoms (1000–6000 m) occurring across a relatively short horizontal distance (Freitas, 2004); multiple ships (in this instance, five) were operating MFAS in the same area over extended periods of time (in this case, 20 hours) in close proximity; exercises took place in an area surrounded by landmasses, or in an embayment. Exercises involving multiple ships employing MFAS near land may have produced sound directed towards a channel or embayment that may have cut off the lines of egress for the affected marine mammals (Freitas, 2004).

Hanalei Bay (2004)

On July 3–4, 2004, approximately 150–200 melon-headed whales occupied the shallow waters of the Hanalei Bay, Kaua'i, Hawaii for over 28 hours. Attendees of a canoe blessing observed the animals entering the Bay in a single wave formation at 7 a.m. on July 3, 2004. The animals were observed moving back into the shore from the mouth of the Bay at 9 a.m. The usually pelagic animals milled in the shallow bay and were returned to deeper water with human assistance beginning at 9:30 a.m. on July 4, 2004, and were out of sight by 10:30 a.m.

Only one animal, a calf, was known to have died following this event. The animal was noted alive and alone in the Bay on the afternoon of July 4, 2004 and was found dead in the Bay the morning of July 5, 2004. A full necropsy, magnetic resonance imaging, and computerized tomography examination were performed on the calf to determine the manner and cause of death. The combination of imaging, necropsy and histological analyses found no evidence of infectious, internal traumatic, congenital, or toxic factors. Although cause of death could not be definitively determined, it is likely that maternal separation, poor nutritional condition, and dehydration contributed to the final demise of the animal. Although we do not know when the calf was separated from its mother, the movement into the Bay, the milling and re-grouping may have contributed to the separation or lack of nursing especially if the maternal bond was weak or this was a primiparous calf.

Environmental factors, abiotic and biotic, were analyzed for any anomalous occurrences that would have contributed to the animals entering and remaining in Hanalei Bay. The Bay's bathymetry is similar to many other sites within the Hawaiian Island chain and dissimilar to sites that have been associated with mass strandings in other parts of the United States. The weather conditions appeared to be normal for that time of year with no fronts or other significant features noted. There was no evidence of unusual distribution or occurrence of predator or prey species, or unusual harmful algal blooms, although Mobley *et al.*, 2007 suggested that the full moon cycle that occurred at that time may have influenced a run of squid into the Bay Weather patterns and bathymetry that have been associated with mass strandings elsewhere were not found to occur in this instance.

The Hanalei event was spatially and temporally correlated with RIMPAC. Official sonar training and tracking exercises in the Pacific Missile Range Facility (PMRF) warning area did not commence until approximately 8 a.m. on July 3 and were thus ruled out as a possible trigger for the initial movement into the Bay.

However, six naval surface vessels transiting to the operational area on July 2 intermittently transmitted active sonar (for approximately 9 hours total from 1:15 p.m. to 12:30 a.m.) as they approached from the south. The potential for these transmissions to have triggered the whales' movement into Hanalei Bay was investigated. Analyses with the information available indicated that animals to the south and east of Kaua'i could have detected active sonar transmissions on July 2, and reached Hanalei Bay on or before 7 a.m. on July 3, 2004. However, data limitations regarding the position of the whales prior to their arrival in the Bay, the magnitude of sonar exposure, behavioral responses of melon-headed whales to acoustic stimuli, and other possible relevant factors preclude a conclusive finding regarding the role of sonar in triggering this event. Propagation modeling suggest that transmissions from sonar use during the July 3 exercise in the PMRF warning area may have been detectable at the mouth of the Bay. If the animals responded negatively to these signals, it may have contributed to their continued presence in the Bay. The U.S. Navy ceased all active sonar transmissions during exercises in this range on the afternoon of July 3, 2004. Subsequent to the cessation of sonar use, the animals were herded out of the Bay.

While causation of this stranding event may never be unequivocally determined, we consider the active sonar transmissions of July 2–3, 2004, a plausible, if not likely, contributing factor in what may have been a confluence of events. This conclusion is based on: (1) The evidently anomalous nature of the stranding; (2) its close spatiotemporal correlation with wide-scale, sustained use of sonar systems previously associated with stranding of deep-diving marine mammals; (3) the directed movement of two groups of transmitting vessels toward the southeast and southwest coast of Kauai; (4) the results of acoustic propagation modeling and an analysis of possible animal transit times to the Bay; and (5) the absence of any other compelling causative explanation. The initiation and persistence of this event may have resulted from an interaction of biological and physical factors. The biological factors may have included the presence of an apparently uncommon, deep-diving cetacean species (and possibly an offshore, non-resident group), social interactions among the animals before or after they entered the Bay, and/or unknown predator or prey conditions. The physical factors may have included the presence of nearby deep water, multiple vessels transiting in a directed manner while transmitting active sonar over a sustained period, the presence of surface sound ducting conditions, and/or intermittent and random human interactions while the animals were in the Bay.

A separate event involving melon-headed whales and rough-toothed dolphins took place over the same period of time in the Northern Mariana Islands (Jefferson *et al.*, 2006), which is several thousand miles from Hawaii. Some 500–700 melon-headed whales came into Sasanhaya Bay on 4 July 2004 on the island of Rota and then left of their own accord after 5.5 hours; no known active sonar transmissions occurred in the vicinity of that event. The Rota incident led to scientific debate regarding what, if any, relationship the event had to the simultaneous events in Hawaii and whether they might be related by some common factor (e.g., there was a full moon on July 2, 2004 as well as during other melon-headed whale strandings and nearshore aggregations (Brownell *et al.* 2009; Lignon, *et al.* 2007; Mobley *et al.* 2007). Brownell *et al.*, (2009) compared the two incidents, along with one other stranding incident at Nuka Hiva in French Polynesia and normal resting behaviors observed at Palmyra Island, in regard to physical features in the areas, melon-headed whale behavior, and lunar cycles. Brownell *et al.*, (2009) concluded that the rapid entry of the whales into Hanalei Bay, their movement into very shallow water far from the 100-m contour, their milling behavior (typical pre-stranding behavior), and their reluctance to leave the bay constituted an unusual event that was not similar to the events that occurred at Rota (but was similar to the events at Palmyra), which appear to be similar to observations of melon-headed whales resting normally at Palmyra Island. Additionally, there was not a correlation between lunar cycle and the types of behaviors observed in the Brownell *et al.*, (2009) examples.

Association Between Mass Stranding Events and Exposure to MFAS

Several authors have noted similarities between some of these 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 ships transmitting MFAS (Cox *et al.*, 2006, D'Spain *et al.*, 2006). Although Cuvier's beaked whales have been the most common species involved in these stranding events (81% of the total number of stranded animals), other beaked whales (including *Mesoplodon europeaus*, *M. densirostris*, and *Hyperoodon ampullatus*) comprise 14% of the total. Other species, such as *Kogia breviceps*, have stranded in association with the operation of MFAS, but in much lower numbers and less consistently than beaked whales.

Based on the evidence available, 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 makes them more likely to strand, or (c) they are more likely to be exposed to MFAS than other cetaceans (for reasons that remain unknown). Because the association between active sonar exposures and marine mammals mass stranding events is not consistent—some marine mammals strand without being exposed to active 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 MFAS That May Lead to Stranding

Although the confluence of Navy MFAS 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 be injured and to strand.

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 startled 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), which would increase their oxygen. 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 MFAS. 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 active 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 (*Tursiops truncatus*) 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 of up to 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 meters 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 for *Ziphius*), perhaps as a consequence of an extended avoidance reaction to active 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 rapid rates of ascent 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 MFAS (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). Baird *et al.* (2008), in a beaked whale tagging study off Hawaii, showed that deep dives are equally common during day or night, but ''bounce dives'' are typically a daytime behavior, possibly associated with visual predator avoidance (Baird *et al.*, 2008). This may indicate that ''bounce dives'' are associated with something other than behavioral regulation of dissolved nitrogen levels, which would be necessary day and night.

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 there is either scientific disagreement or a lack of information regarding each of 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 the post mortem artifacts introduced by decomposition before sampling, handling, freezing, or necropsy procedures affect interpretation of observed lesions.

Although not all of the five environmental factors believed to have contributed to the Bahamas stranding (at least 3 surface vessel MFAS sources operating simultaneously or in conjunction with one another, beaked whale presence, surface ducts, steep bathymetry, and constricted channels with limited egress) will be present during exercises in the MIRC Study area (the MIRC study area does not contain similar bathymetric features), NMFS recommends caution when either steep bathymetry, surface ducting conditions (which are present in the MIRC study area), or a constricted channel is present when mid-frequency active sonar is employed by multiple surface vessels simultaneously and cetaceans (especially beaked whales) are present.

LFA Sonar

Analysis of the environmental impacts of the SURTASS LFA sonar system, including the potential for synergistic and cumulative effects with MFAS operation, has been addressed to some degree in the Navy's SURTASS LFA Sonar EISs and more recently in NMFS' August, 2009 biological opinion for SURTASS LFA Sonar. The take of marine mammals incidental to the operation of LFA sonar in the MIRC and elsewhere has been previously authorized by NOAA/NMFS (2002a, 2007).

Although the authorization of take of marine mammals incidental to the operation of LFA sonar will not be considered here because it has already been separately authorized, NMFS has considered more specifically the manner in which LFA sonar and MFAS may interact in a multi-strike group exercise with respect to the potential to impact marine mammals in a manner not previously considered.

As mentioned previously, the military intends to conduct three exercises (multi-strike group exercises) during the five-year duration of the rule that may include both SURTASS LFA and MFA sonar sources. The expected duration of these combined exercises is approximately 14 days. Based on an exercise of this length, an LFA sonar system would be active (i.e., actually transmitting) for no more than approximately 25 hours. Tactical and technical considerations dictate that the LFA sonar ship would typically be tens of miles from the MFA sonar ship when using active sonar.

It is unlikely, but possible, that both LFA and MFA sonar would be active at exactly the same time during a major exercise. In the unlikely event that both systems were operating simultaneously, the likelihood of more than a relatively small number of individual marine mammals being physically present at a time, location, and depth to be able to receive both LFA and MFA sonar signals at levels of concern at the same time is even smaller as the sound from both signals would have attenuated when they reached the marine mammal in question, so even a simultaneous exposure would not be at the full signal of either system. Additionally, few species have maximum sensitivity to both the low and middle frequencies.

In terms of estimating hours of such exposure, assuming an LFA and MFA sonar source transmitting at the same time over a 25-hour period (which is a subset of a nominal 14-day exercise) and based on the fact that the two sources transmit at very different duty cycles, the overlap of the actual signals would be approximately 3.2%, or 0.8 hours (assuming that there is only one MFA sonar ship transmitting). But the possibility of even that overlap must consider the other factors discussed above.

Based on the fact that an LFA sonar ship would be tens of miles away from an MFA ship when using active sonar and that the overlap of the signals would only be about 50 minutes, the potential impacts on marine mammals that might be exposed simultaneously to both MFA and LFA sonars would be limited and not significant.

Exposure to Underwater Detonation of Explosives

Some of the Navy's training exercises include the underwater detonation of explosives. For many of the exercises discussed, inert ordnance is used for a subset of the exercises. For exercises that involve ''shooting'' at a target that is above the surface of the water, underwater explosions only occur when the target is missed, which is the minority of the time (the Navy has historical hit/miss ratios and uses them in their exposure estimates). The underwater explosion from a weapon would send a shock wave and blast noise through the water, release gaseous by-products, create an oscillating bubble, and cause a plume of water to shoot up from the water surface. The effects of an underwater explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; and the standoff distance between the charge and the animals, as well as the sound propagation properties of the environment. Potential impacts can range from brief effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton *et al.*, 1973; O'Keeffe and Young, 1984; DoN, 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN, 2001). Immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN, 2001).'' Generally, exposures to higher levels of impulse and pressure levels would result in worse impacts to an individual animal.

Injuries resulting from a shock wave take place at boundaries between tissues of different density. Different velocities are imparted to tissues of different densities, and this can lead to their physical disruption. Blast effects are greatest at the gas-liquid interface (Landsberg, 2000). Gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Goertner, 1982; Hill, 1978; Yelverton *et al.*, 1973). In addition, gas-containing organs including the nasal sacs, larynx, pharynx, trachea, and lungs may be damaged by compression/expansion caused by the oscillations of the blast gas bubble (Reidenberg and Laitman, 2003). Intestinal walls can bruise or rupture, with subsequent hemorrhage and escape of gut contents into the body cavity. Less severe gastrointestinal tract injuries include contusions, petechiae (small red or purple spots caused by bleeding in the skin), and slight hemorrhaging (Yelverton *et al.*, 1973).

Because the ears are the most sensitive to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound-related trauma associated with blast noise can be theoretically distinct from injury from the shock wave, particularly farther from the explosion. If an animal is able to hear a noise, at some level it can fatigue or damage its hearing by causing decreased sensitivity (Ketten, 1995) (See Noise-induced Threshold Shift Section above). Sound-related trauma can be lethal or sublethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source and are not, technically, pure acoustic trauma (Ketten, 1995). Sublethal impacts include hearing loss, which is caused by exposures to perceptible sounds. Severe damage (from the shock wave) to the ears includes tympanic membrane rupture, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear. Moderate injury implies partial hearing loss due to tympanic membrane rupture and blood in the middle ear. Permanent hearing loss also can occur when the hair cells are damaged by one very loud event, as well as by prolonged exposure to a loud noise or chronic exposure to noise. The level of impact from blasts depends on both an animal's location and, at outer zones, on its sensitivity to the residual noise (Ketten, 1995).

There have been fewer studies addressing the behavioral effects of explosives on marine mammals than MFAS/HFAS. However, though the nature of the sound waves emitted from an explosion is different (in shape and rise time) from MFAS/HFAS, we still anticipate the same sorts of behavioral responses (see Exposure to MFAS/HFAS: Behavioral Disturbance Section) to result from repeated explosive detonations (a smaller range of likely less severe responses would be expected to occur as a result of exposure to a single explosive detonation).

Potential Effects of Vessel Movement and Collisions

Vessel movement in the vicinity of marine mammals has the potential to result in either a behavioral response or a direct physical interaction. Both scenarios are discussed below.

Vessel Movement

There are limited data concerning marine mammal behavioral responses to vessel traffic and vessel noise, and a lack of consensus among scientists with respect to what these responses mean or whether they result in short-term or long-term adverse effects. In those cases where there is a busy shipping lane or where there is large amount of vessel traffic, marine mammals may experience acoustic masking (Hildebrand, 2005) if they are present in the area (e.g., killer whales in Puget Sound; Foote *et al.*, 2004; Holt *et al.*, 2008). In cases where vessels actively approach marine mammals (e.g., whale watching or dolphin watching boats), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Bursk, 1983; Acevedo, 1991; Baker and MacGibbon, 1991; Trites and Bain, 2000; Williams *et al.*, 2002; Constantine *et al.*, 2003), reduced blow interval (Ritcher *et al.*, 2003), disruption of normal social behaviors (Lusseau, 2003; 2006), and the shift of behavioral activities which may increase energetic costs (Constantine *et al.*, 2003; 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson *et al.* (1995). For each of the marine mammals taxonomy groups, Richardson *et al.* (1995) provided the following assessment regarding cetacean reactions to vessel traffic:

Toothed whales: ''In summary, toothed whales sometimes show no avoidance reaction to vessels, or even approach them. However, avoidance can occur, especially in response to vessels of types used to chase or hunt the animals. This may cause temporary displacement, but we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic.''

Baleen whales: ''When baleen whales receive low-level sounds from distant or stationary vessels, the sounds often seem to be ignored. Some whales approach the sources of these sounds. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance maneuvers. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behavior and swim rapidly away. Avoidance is especially strong when a boat heads directly toward the whale.''

It is important to recognize that behavioral responses to stimuli are complex and influenced to varying degrees by a number of factors such as species, behavioral contexts, geographical regions, source characteristics (moving or stationary, speed, direction, etc.), prior experience of the animal, and physical status of the animal. For example, studies have shown that beluga whales reacted differently when exposed to vessel noise and traffic. In some cases, naïve beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km away, and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley *et al.*, 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the St. Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971).

In reviewing more than 25 years of whale observation data, Watkins (1986) concluded that whale reactions to vessel traffic were ''modified by their previous experience and current activity: Habituation often occurred rapidly, attention to other stimuli or preoccupation with other activities sometimes overcame their interest or wariness of stimuli.'' Watkins noticed that over the years of exposure to ships in the Cape Cod area, minke whales (*Balaenoptera acutorostrata*) changed from frequent positive (such as approaching vessels) interest to generally uninterested reactions; finback whales (*B. physalus*) changed from mostly negative (such as avoidance) to uninterested reactions; right whales (*Eubalaena glacialis*) apparently continued the same variety of responses (negative, uninterested, and positive responses) with little change; and humpbacks (*Megaptera novaeangliae*) dramatically changed from mixed responses that were often negative to often strongly positive reactions. Watkins (1986) summarized that ''whales near shore, even in regions with low vessel traffic, generally have become less wary of boats and their noises, and they have appeared to be less easily disturbed than previously. In particular locations with intense shipping and repeated approaches by boats (such as the whale-watching areas of Stellwagen Bank), more and more whales had P [positive] reactions to familiar vessels, and they also occasionally approached other boats and yachts in the same ways.''

Although the radiated sound from Navy vessels will be audible to marine mammals over a large distance, it is unlikely that animals will respond behaviorally (in a manner that NMFS would consider MMPA harassment) to low-level distant shipping noise as the animals in the area are likely to be habituated to such noises (Nowacek *et al.*, 2004). In light of these facts, NMFS does not expect the Navy's vessel movements to result in Level B harassment.

Vessel Strike

Commercial and Navy ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Vanderlaan and Taggart, 2007).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (for example, the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.*, 2004). These species are primarily large, slow moving whales. Smaller marine mammals (for example, bottlenose dolphin) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.,* 2001, Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67%) resulted in serious injury or death (19 or 33% resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 or 35% resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79%) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45% to 75% as vessel speed increased from 10 to 14 knots, and exceeded 90% at 17 knots. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999, Knowlton *et al.,* 1995).

The Jensen and Silber (2003) report notes that the database represents a minimum number of collisions, because the vast majority probably go undetected or unreported. In contrast, Navy vessels are likely to detect any strike that does occur, and they are required to report all ship strikes involving marine mammals. Overall, the percentages of Navy traffic relative to overall large shipping traffic are very small (on the order of 2%).

The probability of vessel and marine mammal interactions occurring in the MIRC Study Area is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of training events; the presence/absence and density of marine mammals; and mitigation measures implemented by the Navy. Currently, the number of Navy vessels operating in the MIRC Study Area varies based on training schedules and can typically range from zero to about ten vessels at any given time. Ship sizes range from 362 ft (110 m) for a nuclear submarine (SSN) to 1,092 ft (331 m) for a nuclear aircraft carrier (CVN). Smaller boats such as RHIBS, LCAC, etc. are also utilized in the MIRC study area. The smaller boats do not contain acoustic sound sources. Speeds are typically within 10 to 14 knots; however, slower or faster speeds are possible depending upon the specific training scenario. Training involving vessel movements occurs intermittently and is variable in duration, ranging from a few hours up to two weeks. These training events are widely dispersed. Consequently, the density of ships within the MIRC Study Area at any given time is extremely low (i.e., less than 0.0002 ships/nm^2). The Navy logs about 1,000 total vessel days within the MIRC Study Area during a typical year. Vessel days was computed as the number of steaming days per year by summing the number of steaming hours proposed in the range complex, dividing by 24 hours per day, and rounding to the nearest 10 days.

Moreover, naval vessels transiting the study area or engaging in the training exercises will not actively or intentionally approach a marine mammal. While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a ''safe speed'' so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions. When whales have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and would be dictated by environmental and other conditions (e.g., safety, weather). For a thorough discussion of mitigation measures, please see the Mitigation section.

Additionally, the majority of ships participating in MIRC training activities have a number of advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following:

- Navy ships have their bridges positioned forward, offering good visibility ahead of the bow.
- Crew size is much larger than that of merchant ships allowing for more potential observers on the bridge.
- Dedicated lookouts are posted during a training activity scanning the ocean for anything detectable in the water; anything detected is reported to the Officer of the Deck.
- Navy lookouts receive extensive training including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals.
- Navy ships are generally much more maneuverable than commercial merchant vessels.

Based on the implementation of Navy mitigation measures and the low density of Navy ships in the Study Area, NMFS has concluded preliminarily that the probability of a ship strike is very low, especially for dolphins and porpoises, killer whales, social pelagic odontocetes and pinnipeds that are highly visible, and/or comparatively small and maneuverable. Though more probable, NMFS also believes that the likelihood of a Navy vessel striking a mysticete or sperm whale is low. The Navy did not request take from a ship strike and based on our preliminary determination, NMFS is not recommending that they modify their request at this time. However, both NMFS and the Navy are currently engaged in a Section 7 consultation under the ESA, and that consultation will further inform our final decision.

Mitigation

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 NDAA of 2004 amended the MMPA as it relates to military-readiness activities and the ITA 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''. The training activities described in the MIRC application are considered military readiness activities.

NMFS reviewed the proposed MIRC activities and the proposed MIRC mitigation measures as described in the Navy's LOA application to determine if they would result in the least practicable adverse effect on marine mammals, which includes 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 effectiveness of the ''military-readiness activity.'' NMFS identified the need to further flesh out the Navy's plan for how to respond in the event of a stranding in the MIRC, and the Navy and NMFS subsequently coordinated and produced the draft Stranding Response Plan for MIRC, which is summarized below and available at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.* Included below are the mitigation measures the Navy initially proposed (see ''Mitigation Measures Proposed in the Navy's LOA Application'') and the Stranding Response Plan that NMFS and the Navy developed (see ''Additional Measure Developed by NMFS and the Navy'' below).

Mitigation Measures Proposed in the Navy's LOA Application

Personnel Training

The use of shipboard lookouts is a critical component of all Navy protective measures. Lookout duties require that they report all objects sighted in the water to the officer of the deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

- All commanding officers (COs), executive officers (XOs), lookouts, officers of the deck (OODs), junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW) helicopter crews will complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). All bridge lookouts will complete both parts one and two of the MSAT; part two is optional for other personnel. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments and general observation information to aid in avoiding interactions with marine species.

• Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968–D).

• Lookout training will include on-the-job instruction under the supervision of a qualified, experienced lookout. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). Personnel being trained as lookouts can be counted among the number of lookeouts required by a particular mitigation measure as long as supervisors monitor their progress and performance.

• Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

• All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.

• All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of MFAS/HFAS.

General Operating Procedures (for All Training Types)

Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species protective measures.

• COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

• While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals.

• On surface vessels equipped with a multi-function active sensor, pedestal mounted ''Big Eye'' (20x110) binoculars will be properly installed and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

• Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968–D).

• After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. (NAVEDTRA 12968–D).

• While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a ''safe speed'', which means the speed at which CO can maintain crew safety and effectiveness of current operational directives, so that the vessel can take action to avoid a collision with any marine mammal.

• When whales have been sighted in the area, Navy vessels will increase vigilance and take all reasonable actions to avoid collisions and close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and would be dictated by environmental and other conditions (e.g., safety, weather).

• Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

• Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

Operating Procedures (for Anti-Submarine Warfare Operations)

• On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.

• All surface ships participating in ASW training events will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as lookouts.

• Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

• Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

• All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

• During MFAS operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

• Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.

• Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

• Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

• Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within or closing to inside 1,000 yds (914 m) of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels (i.e., limit to at most 229 dB for AN/SQS–53C and 219 for AN/SQS–56C, etc)

• Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1000-yd exclusion zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

• Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level (i.e., limit to at most 225 dB for AN/SQS–53C and 215 for AN/SQS–56C, etc.). Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the 500-yd area (at which point the Navy could return to the 6-dB down powerdown, but not full power) or the 1000-yd area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

- Should the marine mammal be detected within or closing to inside 200 yds (183 m) of the sonar dome, active sonar transmissions will cease. Active sonar will not resume until the animal has been seen to leave the 200-yd exclusion zone (at which point the 500 or 1000-yd powerdowns apply until the animal is beyond the 1000-yd exclusion zone), has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.
- Special conditions applicable for dolphin and porpoise only: If, after conducting an initial maneuver to avoid close quarters with dolphin or porpoise, the OOD concludes that dolphins are deliberately closing to ride the vessel's bow wave, no further mitigation actions would be necessary while the dolphin or porpoise continue to exhibit bow wave riding behavior.
- If the need for power-down should arise (as detailed in ''Safety Zones'' above) when the Navy was operating a hull-mounted or sub-mounted source above 235 dB (infrequent) the Navy shall follow the requirements as though they were operating at 235 dB (i.e., the first power-down will be to 229 dB).
- Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- Active sonar levels (generally)—Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving MFAS.

Underwater Detonations (Up to 10-lb Charges)

Exclusion Zones—All training activities involving the use of explosive charges must include exclusion zones for marine mammals to prevent physical and/or acoustic effects to those species. These exclusion zones for demolitions and ship mine countermeasres shall extend in a 700-yard arc (640 m) radius around the detonation site. Should a marine mammal be present within the the surveillance area, the explosive event shall not be started until the animal leaves the area.

Pre-Exercise Surveys—For Demolition and Ship Mine Countermeasures Operations, pre-exercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal. Should such an animal be present within the exclusion area, the explosive event shall be paused until the animal voluntarily leaves the area. The Navy will ensure the exclusion area is clear of marine mammals for a full 30 minutes prior to initiating the explosive event.

Post-Exercise Surveys—Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

Reporting—If there is any evidence that a marine mammal may have been injured or killed by the action, Navy training activities shall be immediately suspended and the action reported immediately to Commander, Navy Marianas who will contact the Commander, Pacific Fleet. The situation shall also be reported to NMFS (see Stranding Plan for details).

Sinking Exercises

The selection of sites suitable for SINKEXs involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 CFR 229.2), and the identification of areas with a low likelihood of encountering ESA-listed species. To meet operational suitability criteria, the locations of SINKEXs must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1000 fathoms (1828 m) deep and at least 50 nm from land. In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

- All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance activities would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- An exclusion zone with a radius of 1.0 nm (1.9 km) would be established around each target. This exclusion zone is based on calculations using a 990-lb (450-kg) H6 net explosive weight high explosive source detonated 5 ft (1.5 m) below the surface of the water, which yields a distance of 0.85 nm (1.57 km) (cold season) and 0.89 nm (1.65 km) (warm season) beyond which the received level is below the 182 decibels (dB) re: 1 micropascal squared-seconds (μPa2-s) threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials (U.S. Navy, 2001). An additional buffer of 0.5 nm (0.9 km) would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which would extend beyond the buffer zone by an additional 0.5 nm (0.9 km), would be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.
- A series of surveillance overflights shall be conducted prior to the event to determine whether marine mammals are present in the exclusion zone. Survey protocol will be as follows:
- Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.
- All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.
- In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE would be informed of

any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.

• On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.

• The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.

• If a marine mammal observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed, whichever occurs first. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. The OCE would determine if the marine mammal is in danger of being adversely affected by commencement of the exercise.

• During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any marine mammal. If a marine mammal is sighted within the exclusion zone or the buffer zone, the OCE would be notified, and the procedure described above would be followed.

• Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no marine mammals were harmed.

• Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.

• Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting—Beaufort Sea State 3 or less. In the event of a sea state of 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

• The exercise would not be conducted unless the exclusion zone or buffer zone could be adequately monitored visually. Should low cloud cover or surface visibility prevent adequate visual monitoring as described previously, the exercise would be delayed until conditions improved, and all of the above monitoring criteria could be met.

• In the unlikely event that any marine mammal is observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to NMFS via the Navy's regional environmental coordinator for purposes of identification (see the draft Stranding Plan for detail).

• An after action report detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NMFS.

Surface-to-Surface Gunnery (Up to 5-Inch Explosive Rounds)

• For exercises using targets towed by a vessel, target-towing vessels shall maintain a trained lookout for marine mammals when feasible. If a marine mammal is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

• A 600 yard (585 m) radius buffer zone will be established around the intended target.

• From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

• The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within it.

Surface-to-Surface Gunnery (Non-Explosive Rounds)

• A 200 yard (183 m) radius buffer zone will be established around the intended target.

• From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

• If applicable, target towing vessels will maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

• The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (Explosive and Non-Explosive Rounds)

• Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals and sea turtles.

• Vessels will expedite the attempt to recover any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.

• Target towing aircraft shall maintain a lookout if feasible. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

Air-to-Surface Gunnery (Explosive and Non-Explosive Rounds)

• A 200 yard (183 m) radius buffer zone will be established around the intended target.

• If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals and sea turtles prior to and during the exercise.

• Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 feet (152–456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited; aircraft must be able to actually see ordnance impact areas.

• The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Small Arms Training (Grenades, Explosive and Non-Explosive Rounds)

Lookouts will visually survey for marine mammals and sea turtles. Weapons will not be fired in the direction of known or observed marine mammals or sea turtles.

Air-to-Surface At-Sea Bombing Exercises (Explosive Bombs and Rockets)

- Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed sea turtles or marine mammals.
- A buffer zone of 1,000 yards (914 m) radius will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the ''wingman,'' will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons.
- Survey aircraft should employ most effective search tactics and capabilities.
- The exercises will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (Non-Explosive Bombs and Rockets)

- If surface vessels are involved, trained lookouts will survey for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed sea turtles or marine mammals.
- A 1,000 yard (914 m) radius buffer zone will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet (152 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the ''wingman,'' will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities.
- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface Missile Exercises (explosive and non-explosive)—Aircraft will visually survey the target area for marine mammals. Visual inspection of the target area will be made by flying at 1,500 (457 m) feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals.

Aircraft Training Activities Involving Non-Explosive Devices

Non-explosive devices such as some sonobuoys, inert bombs, and Mining Training Activities involve aerial drops of devices that have the potential to hit marine mammals and sea turtles if they are in the immediate vicinity of a floating target. The exclusion zone, as established above for each non-explosive exercise type and if not-defined above, the minimum exclusion zone is 200 yards, shall be clear of marine mammals and sea turtles around the target location. Pre- and post-surveillance and reporting requirements outlined for underwater detonations shall be implemented during Mining Training Activities.

Explosive Source Sonobuoys Used in EER/IEER (AN/SSQ–110A)

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.
- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 914 m (1,000 yd) of observed marine mammal activity, deploy the receiver only and monitor while conducting a visual search. When marine mammals are no longer detected within 914 m (1,000 yd) of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ–110A) (source) with the receiver.
- When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of RF range of these sensors.
- Aural Detection—If the presence of marine mammals is detected aurally, then that should cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.
- Visual Detection—If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ–110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety buffer, whichever occurs first. Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety buffer.
- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the ''Payload 1 Release'' command followed by the ''Payload 2 Release'' command. Aircrews shall refrain from using the ''Scuttle'' command when two payloads remain at a given post. Aircrews will ensure that a 914 m (1,000 yd) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search training activities.
- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary (detonation occurs by timer approximately 6 hours after water entry) or tertiary (detonation occurs by salt water soluble plug approximately 12 hours after water entry) method.

• Aircrews shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ–110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

• Mammal monitoring shall continue until out of own-aircraft sensor range.

Stranding Response Plan for MIRC

NMFS and the Navy have developed a draft Stranding Response Plan for Major Exercises in the MIRC Study Area (available at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm*). Pursuant to 50 CFR 216.105, the plan will be included as part of (attached to) the Navy's MMPA Letter of Authorization (LOA), which contains the conditions under which the Navy is authorized to take marine mammals pursuant to training activities in the MIRC Study Area. The Stranding Response plan is specifically intended to outline the applicable requirements the authorization is conditioned upon in the event that a marine mammal stranding is reported in the MIRC Study Area during a major training exercise (MTE) (see glossary below). NMFS considers all plausible causes within the course of a stranding investigation and this plan in no way presumes that any strandings in the MIRC Study Area are related to, or caused by, Navy training activities, absent a determination made in a Phase 2 Investigation, as outlined in Paragraph 7 of this plan, indicating that MFAS or explosive detonation in the MIRC Study Area were a cause of the stranding. This plan is designed to address the following three issues:

• Mitigation—When marine mammals are in a situation that can be defined as a stranding (see glossary of plan), they are experiencing physiological stress. When animals are stranded, and alive, NMFS believes that exposing these compromised animals to additional known stressors would likely exacerbate the animal's distress and could potentially cause its death. Regardless of the factor(s) that may have initially contributed to the stranding, it is NMFS' goal to avoid exposing these animals to further stressors. Therefore, when live stranded cetaceans are in the water and engaged in what is classified as an Uncommon Stranding Event (USE) (see glossary of plan), the shutdown component of this plan is intended to minimize the exposure of those animals to MFAS and explosive detonations, regardless of whether or not these activities may have initially played a role in the event.

• Monitoring—This plan will enhance the understanding of how MFAS/HFAS or IEER (as well as other environmental conditions) may, or may not, be associated with marine mammal injury or strandings. Additionally, information gained from the investigations associated with this plan may be used in the adaptive management of mitigation or monitoring measures in subsequent LOAs, if appropriate.

• Compliance—The information gathered pursuant to this protocol will inform NMFS' decisions regarding compliance with Sections 101(a)(5)(B) and (C) of the MMPA.

The Stranding Response Plan has several components:

Shutdown Procedures—When an uncommon stranding event (USE—defined in the plan) occurs during a major exercise in the MIRC Study Area, and a live cetacean(s) is in the water exhibiting indicators of distress (defined in the plan), NMFS will advise the Navy that they should cease MFAS/HFAS operation and explosive detonations within 14 nm of the live animal involved in the USE (NMFS and Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures). This distance is the approximate distance at which sounds from the sonar sources are anticipated to attenuate to 145 dB (SPL). The risk function predicts that less than 1 percent of the animals exposed to sonar at this level (mysticete or odontocete) would respond in a manner that NMFS considers Level B Harassment.

Memorandum of Agreement (MOA)—The Navy and NMFS will develop an MOA, or other mechanism consistent with federal fiscal law requirements (and all other applicable laws), that allows the Navy to assist NMFS with the Phase 1 and 2 Investigations of USEs through the provision of in-kind services, such as (but not limited to) the use of plane/boat/truck for transport of stranding responders or animals, use of Navy property for necropsies or burial, or assistance with aerial surveys to discern the extent of a USE. The Navy may assist NMFS with the investigations by providing one or more of the in-kind services outlined in the MOA, when available and logistically feasible and when the provision does not negatively affect Fleet operational commitments.

Communication Protocol—Effective communication is critical to the successful implementation of this Stranding Response Plan. Very specific protocols for communication, including identification of the Navy personnel authorized to implement a shutdown and the NMFS personnel authorized to advise the Navy of the need to implement shutdown procedures and the associated phone trees, etc. are currently in development and will be refined and finalized for the Stranding Response Plan prior to the issuance of a final rule (and updated yearly).

Stranding Investigation—The Stranding Response Plan also outlines the way that NMFS plans to investigate any strandings (providing staff and resources are available) that occur during major training exercises in the MIRC.

Mitigation Conclusions

NMFS has carefully evaluated the Navy's proposed mitigation measures and considered a broad range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable adverse impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another:

• The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals,

• The proven or likely efficacy of the specific measure to minimize adverse impacts as planned,

• The practicability of the measure for applicant implementation, including consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

In some cases, additional mitigation measures are required beyond those that the applicant proposes. Any mitigation measure(s) prescribed by NMFS should be able 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 biologically important time or location) exposed to received levels of MFAS/HFAS, underwater detonations, 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 MFAS/HFAS, underwater detonations, 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 MFAS/HFAS, underwater detonations, or other activities 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) Avoidance or minimization of 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.).

Based on our evaluation of the Navy's proposed measures, as well as other measures considered by NMFS or recommended by the public, NMFS has determined preliminarily that the Navy's proposed mitigation measures (especially when the Adaptive Management component is taken into consideration (see Adaptive Management below)) are adequate means of effecting the least practicable adverse impacts on marine mammals species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, while also considering personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity. Further detail is included below.

The proposed rule comment period will afford the public an opportunity to submit recommendations, views and/or concerns regarding this action and the proposed mitigation measures. While NMFS has determined preliminarily that the Navy's proposed mitigation measures will effect the least practicable adverse impact on the affected species or stocks and their habitat, NMFS will consider all public comments to help inform our final decision. Consequently, the proposed mitigation measures may be refined, modified, removed, or added to prior to the issuance of the final rule based on public comments received, and where appropriate, further analysis of any additional mitigation measures.

NMFS believes that the range clearance procedures and shutdown/safety zone/exclusion zone measures the Navy has proposed will enable the Navy to avoid injuring marine mammals and will enable them to minimize the numbers of marine mammals exposed to levels associated with TTS for the following reasons:

MFAS/HFAS

The Navy's standard protective measures indicate that they will ensure powerdown of MFAS/HFAS by 6-dB when a marine mammal is detected within 1000 yd (914 m), powerdown of 4 more dB (or 10-dB total) when a marine mammal is detected within 500 yd (457 m), and will cease MFAS/HFAS transmissions when a marine mammal is detected within 200 yd (183 m).

PTS/Injury—NMFS believes that the proposed mitigation measures will allow the Navy to avoid exposing marine mammals to received levels of MFAS/HFAS sound that would result in injury for the following reasons:

- The estimated distance from the most powerful source at which cetaceans would receive levels at or above the threshold for PTS/injury/Level A Harassment is approximately 10 m (10.9 yd).
- NMFS believes that the probability that a marine mammal would approach within the above distances of the sonar dome (to the sides or below) without being seen by the watchstanders (who would then activate a shutdown if the animal was within 200 yd (183 m)) is very low, especially considering that animals would likely avoid approaching a source transmitting at that level at that distance.
- The model predicted that one pantropical dolphin and one sperm whale would be exposed to levels associated with injury, however, the model does not consider the mitigation or likely avoidance behaviors and NMFS believes that injury is unlikely when those factors are considered.

TTS—NMFS believes that the proposed mitigation measures will allow the Navy to minimize exposure of marine mammals to received levels of MFAS/HFAS sound associated with TTS for the following reasons:

- The estimated maximum distance from the most powerful source at which cetaceans would receive levels at or above the threshold for TTS is approximately 140 m from the source in most operating environments.
- Based on the size of the animals, average group size, behavior, and average dive time, NMFS believes that the probability that Navy watchstanders will visually detect mysticetes or sperm whales, dolphins, and social pelagic species (pilot whales, melon-headed whales, etc.) at some point within the 1000 yd (914 km) safety zone before they are exposed to the TTS threshold levels is high, which means that the Navy would often be able to shutdown or powerdown to avoid exposing these species to sound levels associated with TTS.
- However, more cryptic animals that are difficult to detect and observe, such as deep-diving cetaceans (beaked whales and *Kogia* spp.), are less likely to be visually detected and could potentially be exposed to levels of MFAS/HFAS expected to cause TTS. However, animals at depth in one location would not be expected to be continuously exposed to repeated sonar signals given the typical 10–14 knot speed of Navy surface ships during ASW events. During a typical one-hour subsurface dive by a beaked whale, the ship will have moved over 5 to 10 nm from the original location.
- Additionally, the Navy's bow-riding mitigation exception for dolphins may sometimes result in dolphins being exposed to levels of MFAS/HFAS likely to result in TTS. However, there are combinations of factors that reduce the acoustic energy received by dolphins approaching ships to ride in bow waves. Dolphins riding a ship's bow wave are outside of the main beam of the MFAS vertical beam pattern. Source levels drop quickly outside of the main beam. Sidelobes of the radiate beam pattern that point to the surface are significantly lower in power. Together with spherical spreading losses, received levels in the ship's bow wave can be more than 42 dB less than typical source level (i.e., 235 dB − 42 dB = 193 dB SPL). Finally, bow wave riding dolphins are frequently in and out of a bubble layer generated by the breaking bow waves. This bubble layer is an excellent scatterer of acoustic energy and can further reduce received energy.

The Stranding Response Plan will minimize the probability of distressed live-stranded animals responding to the proximity of sonar in a manner that further stresses them or increases the potential likelihood of mortality.

Underwater Explosives

The Navy utilizes exclusion zones (wherein explosive detonation will not begin/continue if animals are within the zone) for explosive exercises. Table 3 identifies the various explosives, the estimated distance at which animals will receive levels associated with take (see Acoustic Take Criteria Section), and the exclusion zone associated with the explosive types.

Mortality and Injury—NMFS believes that the mitigation measures will allow the Navy to avoid exposing marine mammals to underwater detonations that would result in injury or mortality for the following reasons:

- Surveillance for large charges (which includes aerial and passive acoustic detection methods, when available, to ensure clearance) begins two hours before the exercise and extends to 2 nm (3704 m) from the source. Surveillance for all charges extends out 3–50 times the farthest distance from the source at which injury would be anticipated to occur (see Table 3).
- Animals would need to be less than 426 m (465 yd) (large explosives) or 8–160 m (9–175 yd) (smaller charges) from the source to be injured.
- Unlike for active sonar, an animal would need to be present at the exact moment of the explosion(s) (except for the short series of gunfire example in GUNEX) to be taken.
- The model predicted that 0 animals would be exposed to explosive levels associated with injury or death.
- When the implementation of the exclusion zones (i.e., the fact that the Navy will not start a detonation or will not continue to detonate explosives if an animal is detected within the exclusion zone) is considered in combination with the factors described in the above bullets, NMFS believes that the Navy's mitigation will prevent injury and mortality to marine mammals from explosives.

TTS—NMFS believes that the proposed mitigation measures will allow the Navy to minimize the exposure of marine mammals to underwater detonations that would result in TTS for the following reasons:

- 43 animals annually were predicted to be exposed to explosive levels that would result in TTS. For the reasons explained above, NMFS believes that most modeled TTS takes can be avoided, especially dolphins, mysticetes and sperm whales, and social pelagic species.
- However, more cryptic, deep-diving species (beaked whales and *Kogia* spp.) are less likely to be visually detected and could potentially be exposed to explosive levels expected to cause TTS. The model estimated that 4 beaked whales and zero Kogia would be exposed to TTS levels.
- Additionally, for SINKEXs, the distance at which an animal would be expected to receive sound or pressure levels associated with TTS (182 dB SEL or 23 psi) is sometimes (when the largest explosive type, the MK–84, is used) larger than the exclusion zone, which means that for those two exercise types, some individuals will likely be exposed to levels associated with TTS outside of the exclusion zone.

Research

The Navy provides a significant amount of funding and support to marine research. In the past five years the agency funded over $100 million ($26 million in FY08 alone) to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors 70% of all U.S. research concerning the effects of human-generated sound on marine mammals and 50% 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.

This research is directly applicable to Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ active sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the 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.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Marine Mammal and sea turtle density estimates for Guam and the CNMI (DoN 2007). Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. 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; and future research as described previously.

Long-Term Prospective Study

Apart from this proposed rule, 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 and record the types of pathologies and diseases and investigate the relationship with potential causal factors (e.g., active sonar, seismic, weather). The study will not be a true ''cohort'' study, because we will be unable to quantify or estimate specific active sonar or other sound exposures for individual animals that strand. However, a cross-sectional or correlational analyses, 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 active 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 active 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.

Monitoring

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

(b) An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to MFAS/HFAS (at specific received levels), explosives, or other stimuli expected to result in take.

(c) An increase in our understanding of how anticipated takes of 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).

(d) An increased knowledge of the affected species,

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

(f) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization,

(g) 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 better achieve the above goals.

Proposed Monitoring Plan for the MIRC

The Navy has submitted a draft Monitoring Plan for the MIRC which may be viewed at NMFS' Web site: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*. The plan may be modified or supplemented based on comments or new information received from the public during the public comment period. A summary of the primary components of the plan follows.

The draft Monitoring Plan for MIRC has been designed as a collection of focused ''studies'' (described fully in the MIRC draft Monitoring Plan) to gather data that will allow the Navy to address the following questions:

(a) Are marine mammals exposed to MFAS/HFAS, especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

(b) If marine mammals are exposed to MFAS/HFAS in the MIRC Range Complex, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

(c) If marine mammals are exposed to MFAS/HFAS, what are their behavioral responses to various levels?

(d) What are the behavioral responses of marine mammals that are exposed to explosives at specific levels?

(e) Is the Navy's suite of mitigation measures for MFAS/HFAS (e.g., measures agreed to by the Navy through permitting) effective at preventing TTS, injury, and mortality of marine mammals?

Data gathered in these studies will be collected by qualified, professional marine mammal biologists that are experts in their field. They will use a combination of the following methods to collect data:

- Contracted third party vessel surveys.
- Passive acoustic monitoring.
- Marine mammal observers on Navy ships.
- Shore-based monitoring.

In the four proposed study designs (all of which cover multiple years), the above methods will be used separately or in combination to monitor marine mammals in different combinations before, during, and after training activities utilizing MFAS/HFAS.

This monitoring plan has been designed to gather data on all species of marine mammals that are observed in the MIRC, however, where appropriate priority will be given to ESA-listed species, beaked whales and other deep-diving species (Kogia, melon-headed whales, and false-killer whales). The Plan recognizes that deep-diving and cryptic species of marine mammals such as beaked whales have a low probability of detection (Barlow and Gisiner, 2006). Therefore, methods will be utilized to attempt to address this issue (e.g., passive acoustic monitoring).

In addition to the Monitoring Plan for MIRC, by the end of 2009, the Navy will have completed an Integrated Comprehensive Monitoring Program (ICMP) Plan. The ICMP will provide the overarching structure and coordination that will, over time, compile data from both range specific monitoring plans (such as AFAST, the Hawaii Range Complex, the Southern California Range Complex, and the Northwest Training Range Complex) as well as Navy funded research and development (R&D) studies. The primary objectives of the ICMP are to:

- Coordinate monitoring and assessment of the effects of Navy activities on protected species;
- Ensure data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations;
- Assess the efficacy and practicability of monitoring and mitigation techniques; and
- Add to the overall knowledge base on potential behavioral and physiological effects to marine species from Navy activities.

More information about the ICMP may be found in the draft Monitoring Plan for MIRC.

Monitoring Workshop

The Navy, with guidance and support from NMFS, will convene a Monitoring Workshop, including marine mammal and acoustic experts as well as other interested parties, in 2011. The Monitoring Workshop participants will review the monitoring results from the first two years of monitoring pursuant to this MIRC rule as well as monitoring results from other Navy rules and LOAs (e.g., the Southern California Range Complex (SOCAL), Hawaii Range Complex (HRC), etc.). The Monitoring Workshop participants would provide their individual recommendations to the Navy and NMFS on the monitoring plan(s) after also considering the current science (including Navy research and development) and working within the framework of available resources and feasibility of implementation. NMFS and the Navy would then analyze the input from the Monitoring Workshop participants and determine the best way forward from a national perspective. Subsequent to the Monitoring Workshop, modifications would be applied to monitoring plans as appropriate.

Past Monitoring in the MIRC Study Area

NMFS has received one monitoring report addressing MFAS use in the MIRC. The data contained in the After Action Report (AAR) have been considered in developing mitigation and monitoring measures for the proposed activities contained in this rule. The Navy's AAR may be viewed at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm*. NMFS has reviewed this report and has summarized the results, as related to marine mammal observations, below.

Valiant Shield 07

Valiant Shield 07 (VS 07) was conducted from August 6, 2007 through August 13, 2007. The ASW training conducted during the VS 07 involved ships, submarines, aircraft, non-explosive exercise weapons, and other training related devices and occurred in the Western Pacific ocean waters south of the Mariana Islands portion of the MIRC (see Figure A–1, Appendix A). MFAS-equipped platforms participating in VS07 include Ticonderoga-class guided missile cruisers (CG), and Arleigh Burke-class guided missile destroyers (DDG) surface combatants with AN/SQS–53C sonar, and associated aviation assets (SH–60B/F/R with AN/AQS–13F or AQS–22 dipping sonar, and AN/SSQ–62B/C/D/E Directional Command Activated Sonobuoy System—DICASS), and P–3 Maritime Patrol Aircraft (MPA) (DICASS sonobuoy).

During VS07, 1,208 hours of MFAS time was reported from all sources including hull-mounted 53C, helicopter dipping sonar, and DICASS sonobuoys.

Table A–2 contains a complete list of VS07 marine mammal visual sightings made by U.S. Navy lookouts and watch teams based on standardized reporting protocols. There were a total of 25 marine mammal sightings for an estimated 235 animals during VS07. As in other U.S. Navy exercise after action reports, the majority of animals sighted were dolphins and porpoises since these species often occur in large schools. For VS07, this was again true with six dolphin sightings accounting for 196 animals or 83% of the total estimated number of animals (196 of 235).

None of the watchstanders reported any sort of ''observed effect'' on the marine mammals that were observed in the ten instances when the sonar was on.

Post-Exercise Aerial Marine Mammal Survey

Immediately following the exercise, an aerial marine mammal survey was conducted from 13–17 August 2007. This effort represents one of the first summer time marine mammal surveys for the waters south of the Marianas, and was conducted by experienced, independent civilian scientists and crew using NMFS-approved survey protocols.

The first survey day involved circumnavigating the islands of Guam and Rota to detect any stranded or near stranded marine mammals. None were detected on or near coastlines.

Subsequent line-transect surveys encompassed approximately 2,352 km (1270 nautical miles) of linear effort, with transect grids distributed randomly throughout a 163,300 km^2 (63,050 $miles^2$) area. A total of 8 sightings were recorded during the five-day period including seven cetacean and one unidentified turtle species. Cetacean species sighted included a Bryde's whale (*Balaenoptera edeni*), a Cuvier's beaked whale (*Ziphius cavirostris*), spotted dolphins (*Stenella attenuata*), pygmy or dwarf sperm whale (*Kogia* spp.), rough-toothed dolphins (*Steno bredanensis*) and two sightings of unidentified dolphin species. No unusual behavior was detected. More information regarding the findings of these aerial surveys may be found in Appendix B of the VS 07 Monitoring report, which is posted on the NMFS Web site, at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm*.

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Date-Time local	Description of Actions Taken	MFAS time lost (min)	Type of Detection	Night time ?	#	Animal Type	MFAS in use?	MFAS secured ?
08/xx - 1050	Surface ship sights 4 "large whales" traveling at 4000 yards. MFAS not in use. No action taken.		visual		4	lg whale		
08/xx - 1120	Surface ship sights 2 "large whales" traveling at 3000 yards. MFAS not in use. No action taken.		visual		2	lg whale		
08/xx - 1300	Surface ship sights 2 "large whales" traveling at 3000 yards. MFAS not ins use. No action taken.		visual		2	lg whale		
08/06 - 1412	Surface ship sights 20 dolphins at 50 yards closing to ride bow. MFAS not in use. No action taken.		visual		20	dolphin		
08/06 - 0930	Surface ship sights 1 "medium sized whale" traveling at **2000 yards. MFAS in use. MFAS secured**.	Not listed	visual		1	whale	yes	yes
08/07 - 1048	Surface ship sights 5 "small whales" crossing bow from starboard to port. MFAS in not in use. No action taken. *Ship alters course to avoid.*		visual		5	sm whale		
08/07 - 1104	Surface ship sights 5 "dolphins" at 200 yards moving aft along the ship's starboard beam. MFAS not in use. No action taken.		visual		5	dolphin		
08/07 - 1315	Helicopter sights 1 "whale" milling at 400 yards. MFAS not in use. No action taken. *Helicopter changes to new course for 15 minutes.*		visual		1	whale	yes	yes
08/07 - 1414	Helicopter sights 1 "dolphin" traveling at 300 yards. **MFAS in use. Turns MFAS to low power first, then secures. Helicopter relocates away from marine mammals.**	Not listed	visual		1	dolphin	yes	yes
08/08 - 1028	Helicopter sights 5 "whales" traveling. Range not reported. **MFAS in use. MFAS secured for 30 minutes and helicopter relocates away from marine mammals.**	30	visual		5	whale	yes	yes
08/08 - 0407	Surface ship sights 1 "whale" traveling at **3000 yards. MFAS in use. MFAS secured at first sighting** and for 15 minutes until animals depart	15	visual	night	1	whale	yes	yes
08/08 - 1630	Helicopter sights 4 "small whales" traveling at 3000 yards. MFAS not in use. No action taken.		visual		4	sm whale		
08/08 - 0604	Surface ship sights 3 "small whales" traveling at 6000 yards. MFAS not in use. *Ship altered course to avoid.*		visual		3	sm whale		
08/09 - 1320	Surface ships sights 1 "small whale" at traveling at 4000 yards. MFAS not in use. No action taken		visual		1	sm whale		
08/09 - 1920	Surface ship sights 1 "whale" traveling east to west at **6500 yards. MFAS in use. MFAS secured.**	Not listed	visual		1	whale	yes	yes
08/09 - 2212	Surface ship reports unknown number of porpoises estimated at 100 yards based on passive detection		passive	night		porpoise		
08/10 - 1224	Surface ships sights 150 "porpoises" at 200 yards traveling and jumping. MFAS not in use. No action taken.		visual		150	porpoise		
08/10 - 1707	Helicopter sights 2 "whales" spouting at 2000 yards. **MFAS in use. MFAS secured and helicopter relocates away from marine**	Not listed	visual		2	whale	yes	yes

Date-Time local	Description of Actions Taken	MFAS time lost (min)	Type of Detection	Night time ?	#	Animal Type	MFAS in use?	MFAS secured ?
	mammals.							
08/10 - 0249	Surface ship reports 4 "small whales" traveling at 33000 yards detected by sonar		active	night	4	sm whale		
08/10 - 0600	Surface ship sights 20 "dolphins" closing to ride bow. First sighted at 200 yards. **MFAS in use. MFAS secured at first sighting and** for 20 minutes until animals depart.	20	visual		20	dolphin	yes	yes
08/11 - 0833	Surface ship sights unknown number of "whales" traveling at 6000 yards. MFAS not in use. No action taken.		visual			whale		
08/12 - 0847	Surface ship sights 1 "whale" traveling at **4500 yards. MFAS in use. MFAS secured at first sighting** and for 48 minutes until animals depart	48	visual		1	whale	yes	yes
08/13 - 1113	Surface ship sights 1 "large whale" traveling at **2000 yards. MFAS in use. MFAS secured at first sighting** and for 23 minutes until animals depart	23	visual		1	lg whale	yes	yes
08/13 - 0400	Surface ship sights 1 "whale" traveling at **3000 yards. MFAS in use. MFAS secured at first sighting** and for 23 minutes until animals depart	23	visual	night	1	whale	yes	yes
08/13 - 0513	Surface ship sights unknown marine mammal at 100 yards. MFAS not in use. No action taken.		visual			unknown		
25	**= total number of sightings**	**159 min or 2.65 hrs**	**= known lost MFAS training time in minutes**		**235**	**= # of marine mammals**		

Table 6A. Marine mammal sightings and actions by exercise participants during VS07. Text in Bold indicate events when MFAS was in use and secured due to marine mammal mitigation.

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General Conclusions Drawn From Review of Monitoring Reports

Because NMFS has received only one monitoring report from sonar training in the MIRC Study Area, it is difficult to draw biological conclusions. However, NMFS can draw some general conclusions from the content of the monitoring reports:

(a) Data from watchstanders is generally useful to indicate the presence or absence of marine mammals within the safety zones (and sometimes without) and to document the implementation of mitigation measures, but does not provide useful species-specific information or behavioral data. Data gathered by independent observers can provide very valuable information at a level of detail not possible with watchstanders (such as data gathered by independent, biologist monitors in Hawaii and submitted to NMFS in a monitoring report, which indicated the presence of sub-adult sei whales in the Hawaiian Islands in fall, potentially indicating the use of the area for breeding).

(b) Though it is by no means conclusory, it is worth noting that no instances of obvious behavioral disturbance were observed by the Navy watchstanders. Of course, these observations only cover the animals that were at the surface (or slightly below in the case of aerial surveys) and within the distance that the observers can see with the big-eye binoculars or from the aircraft.

(c) NMFS and the Navy need to more carefully designate what information should be gathered during monitoring, as some reports contain different information, making cross-report comparisons difficult. This issue is currently being considered in the development of the ICMP.

Adaptive Management

The final regulations governing the take of marine mammals incidental to Navy training exercises in the MIRC will contain an adaptive management component. Our understanding of the effects of MFAS/HFAS and explosives 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 MIRC in the Navy's over 60 years of use of the area for sonar testing and training). The use of adaptive management will allow NMFS to consider new information from different sources to determine (with input from the Navy regarding practicability) on an annual basis if mitigation or monitoring measures should be modified (including additions or deletions) if new data suggest that such modifications 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 MIRC or other locations).

• Findings of the Workshop that the Navy will convene in 2011 to analyze monitoring results to date, review current science, and recommend modifications, as appropriate to the monitoring protocols to increase monitoring effectiveness.

• Compiled results of Navy funded research and development (R&D) studies (presented pursuant to the ICMP, which is discussed elsewhere in this document).

• Results from specific stranding investigations (either from MIRC or other locations, and involving coincident MFAS/HFAS or explosives training or not involving coincident use).

• Results from the Long Term Prospective Study described above.

• Results from general marine mammal and sound research.

• 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.

Mitigation measures could be modified, added, or deleted if new information suggests 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, add, or delete the existing monitoring requirements if the new data suggest that the addition of (or deletion 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 and issue 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 compliance as well as ensuring that the most value is obtained from the required monitoring. Proposed reporting requirements may be modified, removed, or added based on information or comments received during the public comment period. Currently, there are several different reporting requirements pursuant to these proposed regulations:

General Notification of Injured or Dead Marine Mammals

Navy personnel will ensure that NMFS is notified immediately (see Communication Plan) or as soon as clearance procedures allow if an injured, stranded, or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. 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 MIRC Stranding Response Plan contains more specific reporting requirements for specific circumstances.

In the event that an injured, stranded, or dead marine mammal is found by the Navy that is not in the vicinity of, or found during or shortly after MFAS, HFAS, or underwater explosive detonations, the Navy will report the same information as listed above as soon as operationally feasible and clearance procedures allow.

General Notification of a Ship Strike

In the event of a ship strike by any Navy vessel, at any time or place, the Navy shall do the following:

• Immediately report to NMFS the species identification (if known), location (lat/long) of the animal (or the strike if the animal has disappeared), and whether the animal is alive or dead (or unknown).

• Report to NMFS as soon as operationally feasible the size and length of animal, an estimate of the injury status (e.g., dead, injured but alive, injured and moving, unknown, etc.), vessel class/type and operational status.

• Report to NMFS the vessel length, speed, and heading as soon as feasible.

• Provide NMFS a photo or video, if equipment is available.

Annual MIRC Monitoring Plan Report

The Navy shall submit a report annually on November 15 describing the implementation and results (through September 15 of the same year) of the MIRC Monitoring Plan, described above. 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 marine mammal observers (MMOs) collecting marine mammal data pursuant to the MIRC Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in the MFAS/HFAS major Training Exercises section of the Annual MIRC Exercise Report referenced below.

The MIRC Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from multiple Range Complexes.

Annual MIRC Exercise Report

The Navy will submit an Annual MIRC Report on November 15 of every year (covering data gathered through September 15). This report shall contain the subsections and information indicated below.

MFAS/HFAS Major Training Exercises

This section shall contain the following information for the following Coordinated and Strike Group exercises, which for simplicity will be referred to as major training exercises for reporting (MTERs): Joint Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force MIRC:

(a) Exercise Information (for each MTER):

(i) Exercise designator.

(ii) Date that exercise began and ended.

(iii) Location.

(iv) Number and types of active sources used in the exercise.

(v) Number and types of passive acoustic sources used in exercise.

(vi) Number and types of vessels, aircraft, etc., participating in exercise.

(vii) Total hours of observation by watchstanders.

(viii) Total hours of all active sonar source operation.

(ix) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).

(x) Wave height (high, low, and average during exercise).

(b) *Individual marine mammal sighting info (for each sighting in each MTER):*

(i) Location of sighting.

(ii) Species (if not possible—indication of whale/dolphin/pinniped).

(iii) Number of individuals.

(iv) Calves observed (y/n).

(v) Initial Detection Sensor.

(vi) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG).

(vii) Length of time observers maintained visual contact with marine mammal(s).

(viii) Wave height (in feet).

(ix) Visibility.

(x) Sonar source in use (y/n).

(xi) Indication of whether animal is <200yd, 200–500yd, 500–1000yd, 1000–2000yd, or >2000yd from sonar source in (x) above.

(xiii) Mitigation Implementation—Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was.

(xiv) If source in use (x) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel).

(xv) Observed behavior—Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(c) An evaluation (based on data gathered during all of the MTERs) of the effectiveness of mitigation measures designed to avoid exposing marine mammals to MFAS. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

ASW Summary

This section shall include the following information as summarized from non-major training exercises (unit-level exercises, such as TRACKEXs):

(a) *Total Hours*—Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).

(b) *Cumulative Impacts*—To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major training (i.e., ULT) utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across MIRC. The Navy shall include (in the MIRC annual report) a brief annual progress update on the status of the development of an effective and unclassified method to report this information until an agreed-upon (with NMFS) method has been developed and implemented.

Sonar Exercise Notification

The Navy shall submit to the NMFS Office of Protected Resources (specific contact information to be provided in LOA) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any MTER indicating:

(1) Location of the exercise.

(2) Beginning and end dates of the exercise.

(3) Type of exercise.

Improved Extended Echo-Ranging System (IEER)/Advanced Extended Echo-Ranging System (AEER) Summary

This section shall include an annual summary of the following IEER and AEER information:

(i) Total number of IEER and AEER events conducted in MIRC Study Area.

(ii) Total expended/detonated rounds (buoys).

(iii) Total number of self-scuttled IEER rounds.

Sinking Exercises (SINKEXs)

This section shall include the following information for each SINKEX completed that year:

(a) *Exercise information:*

(i) Location

(ii) Date and time exercise began and ended

(iii) Total hours of observation by watchstanders before, during, and after exercise

(iv) Total number and types of rounds expended/explosives detonated

(v) Number and types of passive acoustic sources used in exercise

(vi) Total hours of passive acoustic search time

(vii) Number and types of vessels, aircraft, etc., participating in exercise

(viii) Wave height in feet (high, low and average during exercise)

(ix) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted

(b) Individual marine mammal observation during SINKEX (by Navy lookouts) information:

(i) Location of sighting

(ii) Species (if not possible—indication of whale/dolphin/pinniped)

(iii) Number of individuals

(iv) Calves observed (y/n)

(v) Initial detection sensor

(vi) Length of time observers maintained visual contact with marine mammal

(vii) Wave height

(viii) Visibility

(ix) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after

(x) Distance of marine mammal from actual detonations (or target spot if not yet detonated)—use four categories to define distance: (1) The modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (426 m for SINKEX in MIRC); (2) the required exclusion zone (1 nm for SINKEX in MIRC); (3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in MIRC); and (4) greater than the required observed distance. For example, in this case, the observer would indicate if < 426 m, from 426 m–1 nm, from 1 nm–2 nm, and > 2 nm.

(xi) Observed behavior—Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.

(xii) Resulting mitigation implementation—Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.

(xiii) If observation occurs while explosives are detonating in the water, indicate munitions type in use at time of marine mammal detection.

Explosives Summary

The Navy is in the process of improving the methods used to track explosive use to provide increased granularity. To the extent practicable, the Navy will provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(a) Total annual number of each type of explosive exercise (of those identified as part of the ''specified activity'' in this final rule) conducted in MIRC

(b) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type

MIRC 5-Yr Comprehensive Report

The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual MIRC Exercise Reports and MIRC Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2013), covering activities that have occurred through July15, 2014.

Comprehensive National ASW Report

By June, 2014, the Navy shall submit a draft National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders and pursuant to the implementation of the Monitoring Plans for the Northwest Training Range Complex, the Southern California Range Complex, the Atlantic Fleet Active Sonar Training, the Hawaii Range Complex, the Mariana Islands Range Complex, and the Gulf of Alaska.

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

Estimated Take of Marine Mammals

As mentioned previously, one of the main purposes of NMFS' effects assessments is to identify the permissible methods of taking, meaning: The nature of the take (e.g., resulting from anthropogenic noise vs. from ship strike, etc.); the regulatory level of take (i.e., mortality vs. Level A or Level B harassment) and the amount of take. In the Potential Effects of Exposure of Marine Mammal to MFAS/HFAS and Underwater Detonations section, NMFS identified 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 MFAS/HFAS or underwater explosive detonations. In this section, we will relate the potential effects to marine mammals from MFAS/HFAS and underwater detonation of explosives to the MMPA statutory definitions of Level A and Level B Harassment and attempt to quantify the effects that might occur from the specific training activities that the Navy is proposing in the MIRC.

As mentioned previously, behavioral responses are context-dependent, complex, and influenced to varying degrees by a number of factors other than just received level. For example, an animal may respond differently to a sound emanating from a ship that is moving towards the animal than it would to an identical received level coming from a vessel that is moving away, or to a ship traveling at a different speed or at a different distance from the animal. At greater distances, though, the nature of vessel movements could also potentially not have any effect on the animal's response to the sound. In any case, a full description of the suite of factors that elicited a behavioral response would require a mention of the vicinity, speed and movement of the vessel, or other factors. So, while sound sources and the received levels are the primary focus of the analysis and those that are laid out quantitatively in the regulatory text, it is with the understanding that other factors related to the training are sometimes contributing to the behavioral responses of marine mammals, although they cannot be quantified.

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 Effects of Exposure of Marine Mammal to MFAS/HFAS and Underwater Detonations 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 MFAS/HFAS or underwater detonations (or another stressor), is considered Level B Harassment. Louder sounds (when other factors are not considered) are generally expected to elicit a stronger response. Some of the lower level physiological stress responses discussed in the Potential Effects of Exposure of Marine Mammal to MFAS/HFAS and Underwater Detonations Section: Stress Section 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 would not typically include behaviors ranked 0–3 in Southall *et al.* (2007).

Acoustic Masking and Communication Impairment—The severity or importance of an acoustic masking event can vary based on the length of time that the masking occurs, the frequency of the masking signal (which determines which sounds are masked, which may be of varying importance to the animal), and other factors. Some acoustic masking would be considered Level B Harassment, if 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 disrupt behavioral patterns by inhibiting an animal's ability to communicate with conspecifics and interpret other environmental cues important for predator avoidance and prey capture. However, depending on the degree (elevation of threshold in dB), duration (i.e., recovery time), 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). 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 a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication.

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 either MFAS/HFAS or underwater detonations) as Level B Harassment, not Level A Harassment (injury).

Level A Harassment

Of the potential effects that were described in the Potential Effects of Exposure of Marine Mammals to MFAS/ HFAS and Underwater Detonations Section, following are the types of effects that fall into the Level A Harassment category:

PTS—PTS (resulting from either exposure to MFAS/HFAS or explosive detonations) 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 result in changes in the chemical composition of the inner ear fluids. Although PTS is considered an injury, the effects of PTS on the fitness of an individual can vary based on the degree of TTS and the frequency band that it is in.

Tissue Damage Due to Acoustically Mediated Bubble Growth—A few theories suggest ways in which gas bubbles become enlarged through exposure to intense sounds (MFAS/ HFAS) to the point where tissue damage results. In rectified diffusion, exposure to a sound field would cause bubbles to increase in size. A short duration of active sonar pings (such as that which an animal exposed to MFAS would be most likely to encounter) would not likely be long enough to drive bubble growth to any substantial 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. The degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert because of how close an animal would need to be to the sound source to be exposed to high enough levels, especially considering the likely avoidance of the sound source and the required mitigation. Still, possible tissue damage from either of these processes would be considered an injury or, potentially, mortality.

Tissue Damage Due to Behaviorally Mediated Bubble Growth—Several authors suggest mechanisms in which marine mammals could behaviorally respond to exposure to MFAS/HFAS 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.). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. There is considerable disagreement among scientists as to the likelihood of this phenomenon (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). Although it has been argued that the tissue effects observed from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.,* 2003; Fernandez *et al.,* 2005, Tyack *et al.,* 2006), nitrogen bubble formation as the cause of the traumas has not been verified. If tissue damage does occur by this phenomenon, it would be considered an injury or, potentially, mortality.

Physical Disruption of Tissues Resulting From Explosive Shock Wave—Physical damage of tissues resulting from a shock wave (from an explosive detonation) is classified as an injury. Blast effects are greatest at the gas-liquid interface (Landsberg, 2000) and gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Goertner, 1982; Hill 1978; Yelverton *et al.,* 1973). Nasal sacs, larynx, pharynx, trachea, and lungs may be damaged by compression/ expansion caused by the oscillations of the blast gas bubble (Reidenberg and Laitman, 2003). Severe damage (from the shock wave) to the ears can include tympanic membrane rupture, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear.

Vessel Strike, Ordnance Strike, Entanglement—Although not anticipated (or authorized) to occur, vessel strike, ordnance strike, or entanglement in materials associated with the specified action are considered Level A Harassment or mortality.

Acoustic Take Criteria

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 MFAS/ HFAS and underwater detonations cannot be detected or measured (because, e.g., not all responses are visible external to animal, a portion of exposed animals are underwater, many animals are located many miles from observers and covering very large area, etc.) and because NMFS must authorize take prior to the impacts to marine mammals, 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 developed acoustic criteria that estimate at what received level (when exposed to MFAS/HFAS or explosive detonations) Level B Harassment, Level A Harassment, and mortality (for explosives) of marine mammals would occur. The acoustic criteria for MFAS/HFAS and Underwater Detonations (IEER) are discussed below.

MFAS/HFAS Acoustic Criteria

Because relatively few applicable data exist to support acoustic criteria specifically for HFAS and because such a small percentage of the active sonar pings that marine mammals will likely be exposed to incidental to this activity come from a HFAS source (the vast majority come from MFAS sources), NMFS will apply the criteria developed for the MFAS to the HFAS as well.

NMFS utilizes three acoustic criteria to assess impacts from MFAS/HFAS: PTS (injury—Level A Harassment), TTS (Level B Harassment), and behavioral harassment (Level B Harassment). Because there is related quantitative data, the TTS criterion is a valuable tool for more specifically identifying the likely impacts to marine mammals from MFAS/HFAS, plus the PTS criteria are extrapolated from it. However, TTS is simply a subset of level B Harassment—

the likely ultimate effects of which are not anticipated to necessarily be any more severe than the behavioral impacts that would be expected to occur at the same received levels. Because the TTS and PTS criteria are derived similarly and the PTS criteria are 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 DEIS for MIRC.

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 disturbances are 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). Conversely, TTS is a physiological effect that has been studied and quantified in laboratory conditions. Because data exist to support an estimate of the received levels at which marine mammals will incur TTS, NMFS uses an acoustic criterion to estimate the number of marine mammals that might sustain TTS. TTS is a subset of Level B Harassment.

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 μPa (EL = 192 to 201 dB re 1 μPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μPa and 195 dB re 1 μPa^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 μPa^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 μPa (EL about 213 dB re μPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 μPa. 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 μPa (EL about 193 to 195 dB re 1 μPa^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.
- Finneran *et al.* (2007) conducted TTS experiments with bottlenose dolphins exposed to intense 20 kHz fatiguing tone. Behavioral and auditory evoked potentials (using sinusoidal amplitude modulated tones creating auditory steady state response [AASR]) were used to measure TTS. The fatiguing tone was either 16 (mean = 193 re 1μPa, SD = 0.8) or 64 seconds (185–186 re 1μPa) in duration. TTS ranged from 19–33dB from behavioral measurements and 40–45dB from ASSR measurements.
- 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 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 criterion (which indicates the received level at which onset TTS (>6dB) is induced) for MFAS/HFAS and cetaceans is 195 dB re 1 μPa^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)).

A detailed description of how this TTS criterion was 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 MIRC 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 criterion for injury of cetaceans: 215 dB re 1 μPa^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)).

This criterion is 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 20dB 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 MIRC LOA application. Southall *et al.* (2007) recommend a precautionary dual criteria for TTS (230 dB re 1 μPa (SPL peak pressure) in addition to 215 dB re 1 μPa^2-s (SEL)) to account for the potentially damaging transients embedded within non-pulse exposures. However, in the case of MFAS/HFAS, the distance at which an animal would receive 215 dB (SEL) is farther from the source (i.e., more conservative) than the distance at which they would receive 230 dB (SPL peak pressure) and therefore, it is not necessary to consider 230 dB peak.

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. However, based on the number of years (more than 60) and number of hours of MFAS per year that the U.S. (and other countries) has operated compared to the reported (and verified) cases of associated marine mammal strandings, NMFS believes that the probability of these types of injuries is very low.

Level B Harassment Risk Function (Behavioral Harassment)

In 2006, NMFS issued the first MMPA authorization to allow the take of marine mammals incidental to MFAS (to the Navy for the Rim of the Pacific Exercises (RIMPAC)). 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 173dB 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 (see Figure 1a). In January, 2009, NMFS issued 3 final rules governing the incidental take of marine mammals (Navy's Hawaii Range Complex, Southern California Range Complex, and Atlantic Fleet Active Sonar Training) that used a risk continuum to estimate the percent of marine mammals exposed to various levels of MFAS that would respond in a manner NMFS considers harassment. The Navy and NMFS have previously used acoustic risk functions to estimate the probable responses of marine mammals to acoustic exposures for other training and research programs. Examples of previous application include the Navy FEISs on the SURTASS LFA sonar (U.S. Department of the Navy, 2001c); the North Pacific Acoustic Laboratory experiments conducted off the Island of Kauai (Office of Naval Research, 2001), and the Supplemental EIS for SURTASS LFA sonar (U.S. Department of the Navy, 2007d). 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 that meet NMFS standards of quality become available and can be appropriately and effectively incorporated.

The particular acoustic risk functions developed by NMFS and the Navy (see Figures 1a and 1b) estimate the probability of behavioral responses to MFAS/HFAS (interpreted as the percentage of the exposed population) that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFAS/HFAS. The mathematical function (below) underlying this curve is a cumulative probability distribution adapted from a solution in Feller (1968) and was also used in predicting risk for the Navy's SURTASS LFA MMPA authorization as well.

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

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% risk = 45 dB re: 1 μPa

A = Risk transition sharpness parameter = 10 (odontocetes and pinnipeds) 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 MFAS/HFAS 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 MFAS/HFAS, NMFS has determined that B = 120 dB. 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% risk, or the received level at which we believe 50% 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 data sets 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 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 3-Phase 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. The results from Phase 1 of this study are discussed in the Potential Effects of Specified Activities on Marine Mammals section and the results from Phase 2 are expected to be available in late 2009. Phase 3 was conducted in the Mediterranean Sea in the summer of 2009. Additionally, the Navy recently tagged whales in conjunction with the 2008 RIMPAC exercises; however, analyses of these data are not yet complete. Until additional appropriate data are available, however, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in establishing the K parameter for the MFAS/HFAS 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—at specific received levels—to MFAS and sources within or having components within the range of MFAS (1–10 kHz).

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 D of the Navy's DEIS for MIRC.

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 still 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 1μPa) 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 2 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 μPa^2/hertz [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-second (sec) intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa (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 is 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% 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 μPa 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 (Orcinus orca) 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, 2005; Fromm, 2004a, 2004b; DON, 2003). Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the active 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 animal upon actual exposure to AN/SQS–53 sonar.

U.S. Department of Commerce (National Marine Fisheries, 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. Observations from this reconstruction included an estimate of 169.3 dB SPL which represents the mean level at a point of closest approach within a 500 m wide area in which the animals were exposed. Within that area, the estimated received levels varied from approximately 150 to 180 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 MFAS (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% 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 for the MFAS/HFAS 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 (U.S. Department of the Navy, 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 National Marine Fisheries Service, 2008).

NMFS determined that a lower steepness parameter (A = 8), resulting in a shallower curve, was appropriate for use with mysticetes and MFAS/HFAS. The Nowacek *et al.* (2004) dataset contains the only data illustrating mysticete behavioral responses to a sound source that encompasses frequencies in the mid-frequency sound spectrum. 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 in the Novacek report, and is supported by the only representative dataset currently available.

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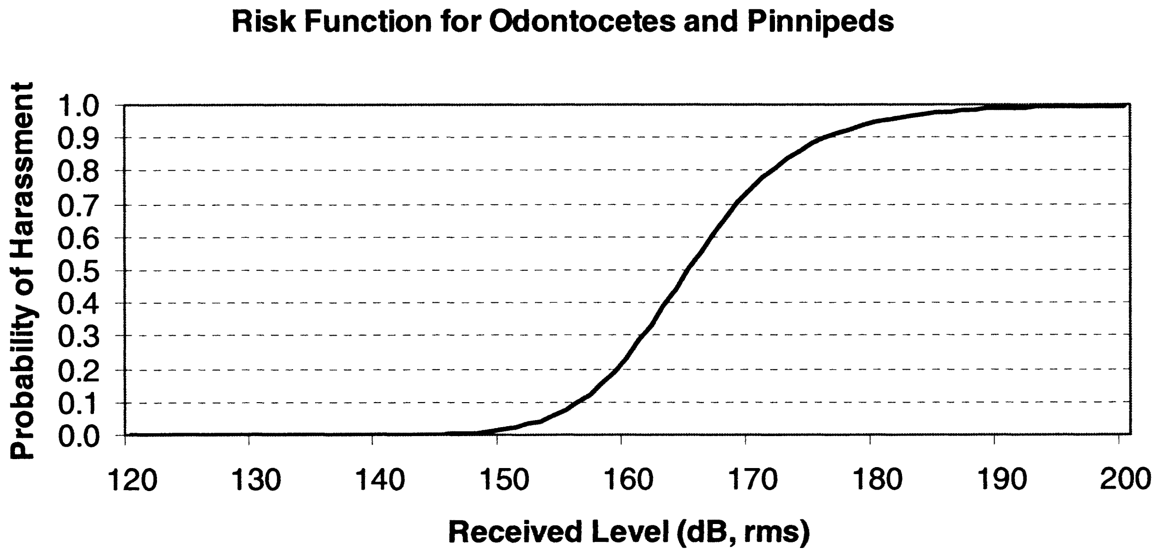

Figure 1a. Risk function for odontocetes and pinnipeds. B=120 dB, K=45 dB, A=10

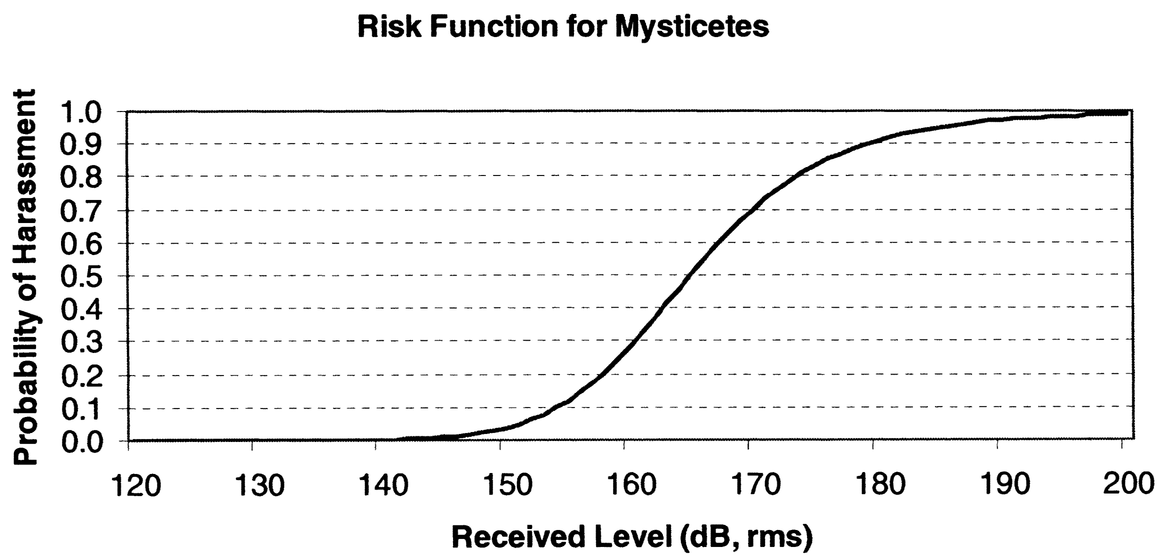

Figure 1b. Risk function for mysticetes. B=120 dB, K=45 dB, A=8.

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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 training with MFAS) at a given received level of sound. For example, at 165 dB SPL (dB re: 1μPa rms), the risk (or probability) of harassment is defined according to this function as 50%, and Navy/NMFS applies that by estimating that 50% 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. Additionally, although these other factors cannot be taken into consideration quantitatively in the risk function, NMFS considers these other variables qualitatively in our analysis, when applicable data are available.

As more specific and applicable data become available for MFAS/HFAS 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 multi-variate 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). In the MIRC example, animals exposed to received levels between 120 and 140 dB will likely be more that 125 km away from a sound source depending on seasonal variations; those distances could influence whether those animals perceive the sound source as a potential threat, and their behavioral responses to that threat. Though there are data showing response of certain marine mammal species to mid-frequency sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to mid-frequency sounds at that distance, much less data that compare responses to similar sound levels at varying distances (much less for MFAS/HFAS). However, if applicable data meeting NMFS standards were to become available, NMFS would re-evaluate the risk function and to incorporate any additional variables into the ''take'' estimates.

Explosive Detonation Criteria

The criteria for mortality, Level A Harassment, and Level B Harassment resulting from explosive detonations were initially developed for the Navy's Seawolf and Churchill ship-shock trials and have not changed. The criteria, which are applied to cetaceans and pinnipeds, are summarized in Table 7. Additional information regarding the derivation of these criteria is available in the Navy's DEIS for the MIRC, the LOA application, and in the Navy's CHURCHILL FEIS (U.S. Department of the Navy, 2001c).

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Type of Effect	Criteria	Metric	Threshold	MMPA
Mortality	Onset of Extensive Lung Injury	Goertner modified positive impulse	indexed to 30.5 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Mortality
Injurious Physiological	50% Tympanic Membrane Rupture	Energy flux density	1.17 in-lb/in^2 (about 205 dB re 1 microPa^2-sec)	Level A Harassment
Injurious Physiological	Onset Slight Lung Injury	Goertner modified positive impulse	indexed to 13 psi-msec (assumes 100 percent small animal at 26.9 lbs)	Level A Harassment
Non-injurious Physiological	TTS	Greatest energy flux density level in any 1/3-octave band (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures	182 dB re 1 microPa^2-sec	Level B Harassment
Non-injurious Physiological	TTS	Peak pressure over all exposures	23 psi	Level B Harassment
Non-injurious Behavioral	Multiple Explosions Without TTS	Greatest energy flux density level in any 1/3-octave (> 100 Hz for toothed whales and > 10 Hz for baleen whales) - for total energy over all exposures (multiple explosions only)	177 dB re 1 microPa^2-sec	Level B Harassment

Table 7. Summary of Explosive Criteria

Estimates of Potential Marine Mammal Exposure

Estimating the take that will result from the proposed activities entails the following three general steps: (1) Propagation model estimates animals exposed to sources at different levels; (2) further modeling determines number of exposures to levels indicated in criteria above (i.e., number of takes); and (3) post-modeling corrections refine estimates to make them more accurate. More information regarding the models used, the assumptions used in the models, and the process of estimating take is available in Appendix A of the Navy's Application.

(1) In order to quantify the types of take described in previous sections that are predicted to result from the Navy's specified activities, the Navy first uses a sound propagation model that predicts the number of animals that will be exposed to a range of levels of pressure and energy (of the metrics used in the criteria) from MFAS/HFAS and explosive detonations based on several important pieces of information, including:

- Characteristics of the sound sources.
- Active sonar source characteristics include: source level (with horizontal and vertical directivity corrections), source depth, center frequency, source directivity (horizontal/vertical beam width and horizontal/vertical steer direction), and ping spacing.
- Explosive source characteristics include: the weight of an explosive, the type of explosive, the detonation depth, and number of successive explosions.
- Transmission loss (in 9 representative environmental provinces in two seasons) based on: water depth; sound speed variability throughout the water column (warm season exhibits a weak surface duct, cold season exhibits a relatively strong surface duct); bottom geo-acoustic properties (bathymetry); and wind speed.
- The estimated density of each marine mammal species in the MIRC (see Table 4), horizontally distributed uniformly and vertically distributed according to dive profiles based on field data.

(2) Next, the criteria discussed in the previous section are applied to the estimated exposures to predict the number of exposures that exceed the criteria, i.e., the number of takes by Level B Harassment, Level A Harassment, and mortality.

(3) During the development of the EIS for MIRC, NMFS and the Navy determined that the output of the model could be made more realistic by applying post-modeling corrections to account for the following:

- Acoustic footprints for active sonar sources must account for land masses (by subtracting them out).
- Acoustic footprints for active sonar sources should not be added independently, rather, the degree to which the footprints from multiple ships participating in the same exercise would typically overlap needs to be taken into consideration.
- Acoustic modeling should account for the maximum number of individuals of a species that could potentially be exposed to active sonar within the course of 1 day or a discrete continuous sonar event if less than 24 hours.

Last, the Navy's specified activities have been described based on best estimates of the number of MFAS/HFAS hours that the Navy will conduct. The exact number of hours may vary from year to year, but will not exceed the 5-year total indicated in Table 8 (by multiplying the yearly estimate by 5) by more than 10%. NMFS estimates that a 10% increase in active sonar hours would result in approximately a 10% increase in the number of takes, and we have considered this possibility in our analysis.

The Navy's model provides a systematic and repeatable way of estimating the number of animals that will be taken by Level A and Level B Harassment. The model is based on the sound propagation characteristics of the sound sources, physical characteristics of the surrounding environment, and a uniform density of marine mammals. As mentioned in the previous sections, many other factors will likely affect how and the degree to which marine mammals are impacted both at the individual and species level by the Navy's activity (such as social ecology of the animals, long term exposures in one area, etc.); however, in the absence quantitative data, NMFS has, and will continue, to evaluate that sort of information qualitatively.

Species	Modeled Sonar Exposures to Indicated Thresholds			Modeled Explosive Exposures to Indicated Thresholds				NMFS Proposed Annual Take Authorization		
	Level B Exposures		Level A Exposures (PTS)	Level B Exposures		Level A Exposures	Mortality			
	Risk Function (Behavioral)	TTS		Sub-TTS	TTS			Level B Harassment	Level A Harassment	Mortality
ESA Species										
Blue whale	128	2	0	0	0	0	0	130	0	
Fin whale	180	2	0	0	0	0	0	182	0	
Humpback whale	794	10	0	0	1	0	0	805	0	
Sei whale	319	6	0	0	0	0	0	325	0	
Sperm whale	807	10	1	6	3	0	0	826	1	
Sei/Bryde's whale	61	1	0	0	0	0	0	62	0	
Unidentified Balaenopterid whale	71	1	0	0	0	0	0	72	0	
Mysticetes										
Bryde's whale	449	8	0	0	0	0	0	457	0	
Minke whale	438	7	0	0	0	0	0	445	0	
Odontocetes										
Blainville's beaked whale	758	12	0	0	0	0	0	770	0	10 over the course of 5-yr rule
Cuvier's beaked whale	3,567	44	0	12	4	0	0	3627	0	
Ginkgo-toothed beaked whale	423	7	0	0	0	0	0	430	0	
Longman's beaked whale	204	2	0	0	0	0	0	206	0	
Bottlenose dolphin	168	3	0	0	0	0	0	171	0	
Bottlenose/Rough-toothed dolphin	72	1	0					73	0	
Fraser's dolphin	4,523	74	0	12	4	0	0	4613	0	
Pantropical spotted dolphin	31,963	510	1	12	8	0	0	32493	1	
Rough-toothed dolphin	236	5	0	0	0	0	0	241	0	
Risso's dolphin	6,627	108	0	26	10	0	0	6771	0	
Short-beaked common dolphin	918	17	0	6	2	0	0	943	0	
Spinner dolphin	2,099	36	0	6	2	0	0	2143	0	
Striped dolphin	8,713	139	0	3	1	0	0	8856	0	
Unidentified delphinid	1,514	24	0	0	0	0	0	1538	0	
Dwarf/Pygmy sperm whale	6,574	103	0	20	6	0	0	6703	0	
False killer whale	1,266	23	0	0	0	0	0	1289	0	
Killer whale	226	4	0	0	0	0	0	230	0	
Melon-headed whale	2,808	46	0	6	2	0	0	2862	0	
Pygmy killer whale	158	2	0	0	0	0	0	160	0	
Short-finned pilot whale	2,238	36	0	0	0	0	0	2274	0	
Total	**78,302**	**1,243**	**2**	**109**	**43**	**0**	**0**	79697	2	

Table 8. Navy's estimated marine mammal exposures to the thresholds and NMFS proposed take authorization.

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Mortality

Evidence from five beaked whale strandings, all of which have taken place outside the MIRC Range Complex, and have occurred over approximately a decade, suggests that the exposure of beaked whales to MFAS in the presence of certain conditions (e.g., multiple units using active sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although not all 5 of these physical factors believed to have contributed to the likelihood of beaked whale strandings are present, in their aggregate, in the MIRC, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings. Accordingly, to allow for scientific uncertainty regarding contributing causes of beaked whale strandings and the exact behavioral or physiological mechanisms that can lead to the ultimate physical effects (stranding and/or death), the Navy has requested authorization for (and NMFS is proposing authorizing) take, by injury or mortality. Although the Navy has requested take by injury or mortality of 10 beaked whales over the course of the 5-yr regulations, the Navy's model did not predict injurious takes of beaked whales and neither NMFS, nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of MFAS during Navy exercises within the MIRC.

Effects on Marine Mammal Habitat

The Navy's proposed training exercises could potentially affect marine mammal habitat through the introduction of pressure, sound, and expendable materials into the water column, which in turn could impact prey species of marine mammals, or cause bottom disturbance or changes in water quality. Each of these components was considered in the MIRC DEIS and was determined by the Navy to have no significant or long term effect on marine mammal habitat. Based on the information below and the supporting information included in the Navy's DEIS, NMFS has preliminarily determined that the MIRC training activities will not have significant or long term impacts on marine mammal habitat. Unless the sound source or explosive detonation is stationary and/or continuous over a long duration in one area, the effects of the introduction of sound into the environment are generally considered to have a less severe impact on marine mammal habitat than the physical alteration of the habitat. Marine mammals may be temporarily displaced from areas where Navy training is occurring, but the area will likely be utilized again after the activities have ceased. A summary of the conclusions are included in subsequent sections.

Effects on Food Resources

Fish

The Navy's DEIS includes a detailed discussion of the effects of active sonar on marine fish. In summary, studies have indicated that acoustic communication and orientation of fish may be restricted by anthropogenic sound in their environment. However, the vast majority of fish species studied to date are hearing generalists and cannot hear sounds above 500 to 1,500 Hz (0.5 to 1.5 kHz) (depending upon the species). Therefore, these fish species are not likely to be affected behaviorally from higher frequency sounds such as MFAS/HFAS. Moreover, even those marine 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, so it is likely that the fish will only actually hear the sounds if the fish and source were fairly 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 likely mask detection of lower frequency biologically relevant sounds. Thus, based on the available information, a reasonable conclusion is that there will be few, and more likely no, impacts on the behavior of fish from active sonar.

Though mortality has been shown to occur in one species, a hearing specialist, as a result of exposure to non-impulsive sources, the available evidence does not suggest that exposures such as those anticipated from MFAS/HFAS would result in significant fish mortality on a population level. The mortality that was observed was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and considering the best available data, no data exist that demonstrate any long-term negative effects on marine fish from underwater sound associated with active sonar activities. Further, while fish may respond behaviorally to mid-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

There are currently no well-established thresholds for estimating effects to fish from explosives other than mortality models. Fish that are located in the water column, in proximity to the source of detonation could be injured, killed, or disturbed by the impulsive sound and possibly temporarily leave the area. Continental Shelf Inc. (2004) summarized a few studies conducted to determine effects associated with removal of offshore structures (e.g., oil rigs) in the Gulf of Mexico. Their findings revealed that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. For most situations, cause of death in fishes has been massive organ and tissue damage and internal bleeding. At longer range, species with gas-filled swimbladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swimbladders (e.g., flounders, eels). Studies also suggest that larger fishes are generally less susceptible to death or injury than small fishes. Moreover, elongated forms that are round in cross section are less at risk than deep-bodied forms; and orientation of fish relative to the shock wave may affect the extent of injury. Open water pelagic fish (e.g., mackerel) also seem to be less affected than reef fishes. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors.

The huge variations in the fish population, including numbers, species, sizes, and orientation and range from the detonation point, make it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience a large number of natural mortalities, especially during early life-stages, and any small level of mortality caused by the MIRC training exercises involving explosives will likely be insignificant to the population as a whole.

Invertebrates

Very little is known about sound detection and use of sound by invertebrates (see Budelmann 1992a, b, Popper *et al.,* 2001 for reviews). The limited data show that some crabs are able to detect sound, and there has been the suggestion that some other groups of invertebrates are also able to detect sounds. In addition, cephalopods (octopus and squid) and decapods (lobster, shrimp, and crab) are thought to sense low-frequency sound (Budelmann, 1992b). Packard *et al.*

(1990) reported sensitivity to sound vibrations between 1–100 Hz for three species of cephalopods. McCauley *et al.* (2000) found evidence that squid exposed to seismic airguns show a behavioral response including inking. However, these were caged animals, and it is not clear how unconfined animals may have responded to the same signal and at the same distances used. In another study, Wilson *et al.* (2007) played back echolocation clicks of killer whales to two groups of squid (*Loligo pealeii*) in a tank. The investigators observed no apparent behavioral effects or any acoustic debilitation from playback of signals up to 199 to 226 dB re 1 μPa. It should be noted, however, that the lack of behavioral response by the squid may have been because the animals were in a tank rather than being in the wild. In another report on squid, Guerra *et al.* (2004) claimed that dead giant squid turned up around the time of seismic airgun operations off of Spain. The authors suggested, based on analysis of carcasses, that the damage to the squid was unusual when compared to other dead squid found at other times. However, the report presents conclusions based on a correlation to the time of finding of the carcasses and seismic testing, but the evidence in support of an effect of airgun activity was totally circumstantial. Moreover, the data presented showing damage to tissue is highly questionable since there was no way to differentiate between damage due to some external cause (e.g., the seismic airgun) and normal tissue degradation that takes place after death, or due to poor fixation and preparation of tissue. To date, this work has not been published in peer reviewed literature, and detailed images of the reportedly damaged tissue are also not available.

In summary, baleen whales feed on the aggregations of krill and small schooling fish, while toothed whales feed on epipelagic, mesopelagic, and bathypelagic fish and squid. As summarized above and in the MIRC EIS/OEIS in more detail, potential impacts to marine mammal food resources within the MIRC is negligible given both lack of hearing sensitivity to mid-frequency sonar, the very geographic and spatially limited scope of most Navy at sea activities including underwater detonations, and the high biological productivity of these resources. No short or long term effects to marine mammal food resources from Navy activities are anticipated within the MIRC.

Military Expendable Material

Marine mammals are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. This section summarizes the potential effects of expended materials on marine mammals. Detailed discussion of military expendable material is contained within the MIRC EIS.

The Navy endeavors to recover expended training materials. Notwithstanding, it is not possible to recover all training materials, and some may be encountered by marine mammals in the waters of the MIRC. Debris related to military activities that is not recovered generally sinks; the amount that might remain on or near the sea surface is low, and the density of such expendable materials in the MIRC would be very low. Types of training materials that might be encountered include: Parachutes of various types (e.g., those employed by personnel or on targets, flares, or sonobuoys); torpedo guidance wires, torpedo ‘‘flex hoses;’’ cable assemblies used to facilitate target recovery; sonobuoys; and EMATT.

Entanglement in military expendable material was not cited as a source of injury or mortality for any marine mammals recorded in a large marine mammal and sea turtle stranding database for California waters, an area with much higher density of marine mammals. Therefore as discussed in the MIRC EIS, expendable material is highly unlikely to directly affect marine mammal species or potential habitat within the MIRC.

NMFS Office of Habitat Conservation is working with the Navy to better identify the potential risks of expended materials from the Navy activities as they relate to Essential Fish Habitat. These effects are indirectly related to marine mammal habitat, but based on the extent of the likely effects described in the Navy's DEIS, NMFS' Office of Protected Resources has preliminarily determined that they will not result in significant impacts to marine mammal habitat. The EFH discussions between Navy and NMFS' Office of Habitat Conservation will further inform the marine mammal habitat analysis in the final rule.

Water Quality

The MIRC EIS/OEIS analyzed the potential effects to water quality from sonobuoy, ADCs, and Expendable Mobile Acoustic Training Target (EMATT) batteries; explosive packages associated with the explosive source sonobuoy (AN/SSQ–110A), and Otto Fuel (OF) II combustion byproducts associated with torpedoes. Expendable bathythermographs do not have batteries and were not included in the analysis. In addition, sonobuoys were not analyzed since, once scuttled, their electrodes are largely exhausted during use and residual constituent dissolution occurs more slowly than the releases from activated seawater batteries. As such, only the potential effects of batteries and explosions on marine water quality in and surrounding the sonobuoy training area were completed. The Navy determined that there would be no significant effect to water quality from seawater batteries, lithium batteries, and thermal batteries associated with scuttled sonobuoys.

ADCs and EMATTs use lithium sulfur dioxide batteries. The constituents in the battery react to form soluble hydrogen gas and lithium dithionite. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydronium formed from hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur ioxide ionizes in the water, forming bisulfite (HSO3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 milligrams per liter [mg/L]) in the ocean. Thus, it was determined that there would be no significant effect to water quality from lithium sulfur batteries associated with scuttled ADCs and EMATTs.

Only a very small percentage of the available hydrogen fluoride explosive product in the explosive source sonobuoy (AN/SSQ–110A) is expected to become solubilized prior to reaching the surface and the rapid dilution would occur upon mixing with the ambient water. As such, it was determined that there would be no significant effect to water quality from the explosive product associated with the explosive source sonobuoy (AN/SSQ–110A).

OF II is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. Combustion byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide, and nitrogen oxides. All of the byproducts, with the exception of hydrogen cyanide, are below the EPA water quality criteria. Hydrogen cyanide is highly soluble in seawater and dilutes below the EPA criterion within 6.3 m (20.7 ft) of the torpedo. Therefore, it was determined there would be no significant effect to water quality as a result of OF II.

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 affected 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 (for example: 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 has a 17-percent reproductive success). 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 Harassment takes, the number of estimated mortalities, and effects on habitat. Generally speaking, and especially with other factors being equal, the Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels.

The Navy's specified activities have been described based on best estimates of the number of MFAS/HFAS hours that the Navy will conduct. The exact number of hours (or torpedoes, or pings, whatever unit the source is estimated in) may vary from year to year, but will not exceed the 5-year total indicated in Table 8 (by multiplying the yearly estimate by 5) by more than 10%. NMFS estimates that a 10-percent increase in active sonar hours (torpedoes, pings, etc.) would result in approximately a 10-percent increase in the number of takes, and we have considered this possibility and the effect of the additional active sonar use in our analysis.

Taking the above into account, considering the sections discussed below, and dependent upon the implementation of the proposed mitigation measures, NMFS has preliminarily determined that Navy training exercises utilizing MFAS/HFAS and underwater detonations will have a negligible impact on the marine mammal species and stocks present in the MIRC Range Complex.

Behavioral Harassment

As discussed in the Potential Effects of Exposure of Marine Mammals to MFAS/HFAS and illustrated in the conceptual framework, marine mammals can respond to MFAS/HFAS in many different ways, a subset of which qualify as harassment (see Behavioral Harassment Section). 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 one extent or another. 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. For MFAS/HFAS, the Navy provided information (Table 9) estimating the percentage of the total takes that will occur within the 10-dB bins (without considering mitigation or avoidance) that are within the received levels considered in the risk continuum and for TTS and PTS. This table applies specifically to AN/SQS–53C hull-mounted active sonar (the most powerful source), with less powerful sources the percentages would increase slightly in the lower received levels and correspondingly decrease in the higher received levels. As mentioned above, an animal's exposure to a higher received level is more likely to result in a behavioral response that is more likely to adversely affect the health of the animal.

Received Level (SPL)	Distance At Which Levels Occur in NWTRC	Percent of Total Harassment Takes Estimated to Occur at Indicated Level
Below 140 dB	36 km - 125 km	< 1%
140 < Level < 150 dB	15 km - 36 km	2%
150 < Level < 160 dB	5 km - 15 km	20%
160 < Level < 170 dB	2 km - 5 km	40%
170 < Level < 180 dB	0.6 m - 2 km	24%
180 < Level < 190 dB	180 m - 600 m	9%
above 190 dB	0 - 180 m	2%
TTS (195 SEL)	0 - 140	2%
PTS (215 SEL)	0 - 10 m	1%

Table 9. Approximate percent of estimated takes that occur in the indicated 10-dB bins for AN/SQS-53 (the most powerful source). For smaller sources, a higher % of the takes occur at lower levels, and a lower % at higher levels.

Because the Navy has only been monitoring specifically to discern the effects of MFAS/HFAS on marine mammals since approximately 2006, and because of the overall data gap regarding the effects of MFAS/HFAS on marine mammals, not a lot is known regarding how marine mammals in the MIRC will respond to MFAS/HFAS. For the one major exercise (Valiant Shield, 2007) for which NMFS has received a monitoring report, no instances of obvious behavioral disturbance were observed by the Navy watchstanders in the 25 marine mammal sightings of 235 animals. The Navy has also submitted reports from more than 60 major exercises conducted in the Southern California Range Complex, the Hawaii Range Complex, and off the Atlantic Coast, that similarly indicate no observed behavioral disturbance observed. One cannot conclude from these results that marine mammals were not harassed from MFAS/HFAS, as a portion of animals within the area of concern were not seen (especially those more cryptic, deep-diving species, such as beaked whales or Kogia spp.) and some of the non-biologist watchstanders might not be well-qualified to characterize behaviors. However, one can say 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 any corresponding 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 (results of first year discussed in previous sections, 2008 results not yet available). Separately, the Navy and NMFS conducted an opportunistic tagging experiment with several species of marine mammals in the area of the 2008 Rim of the Pacific training exercises in the HRC, for which the results are still being analyzed.

Diel Cycle

As noted previously, many animals perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hr cycle). Behavioral reactions to noise exposure (when taking place in a biologically important context, 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 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 MFAS/HFAS that fall into the category of harassment could range in severity. By definition, takes by 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. As indicated in table 2, with the exception of the major exercises (either 1 multi-strike group exercise annually, or 1 Joint Expeditionary exercise and 1–4 MAGTFs annually), which last approximately 10 days, the rest of the sonar exercises conducted in the MIRC are 8 hours in duration or shorter. Additionally, vessels with hull-mounted active sonar are typically moving at speeds of 10–14 knots, which would make it unlikely that the same animal could remain in the immediate vicinity of the ship for the entire duration of the exercise. Animals are not expected to be exposed to MFAS/HFAS at levels or for a duration likely to result in a significant response that would then last for more than one day or on successive days. With the exception of SINKEXs, the planned explosive exercises are also of a short duration (1–6 hours). Although explosive exercises may sometimes be conducted in the same general areas repeatedly, because of their short duration and the fact that they are in the open ocean and animals can easily move away, it is similarly unlikely that animals would be exposed for long, continuous amounts of time. Although SINKEXs may last for up to 48 hours, only 2 are planned annually, they are stationary and conducted in deep, open water (where fewer marine mammals would typically be expected to be randomly encountered), and they have a rigorous monitoring and shutdown protocol, all of which make it unlikely that individuals would be exposed to the exercise for extended periods or in consecutive days.

TTS

NMFS and the Navy have estimated that approximately 1300 individual marine mammals (totaled from all affected species), may sustain some level of TTS from MFAS/HFAS annually. As mentioned previously, TTS can last from a few minutes to days, be of varying degree, and occur across various frequency bandwidths, all of which determine the severity of the impacts on the affected individual, which can range from minor to more severe. Table 8 indicates the estimated number of animals that might sustain TTS from exposure to MFAS/HFAS. 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). The more MF powerful sources used (the two hull-mounted MFAS sources and the DICASS sonobuoys) have center frequencies between 3.5 and 8 kHz and the other unidentified MF sources are, by definition, less than 10 kHz, which suggests that TTS induced by any of these MF sources would be in a frequency band somewhere between approximately 2 and 20 kHz. There are fewer hours of HF source use and the sounds would attenuate more quickly, plus they have lower source levels, but if an animal were to incur TTS from these sources, it would cover a higher frequency range (sources are between 20 and 100 kHz, which means that TTS could range up to 200 kHz; however, HF systems are typically used less frequently and for shorter time periods than surface ship and aircraft MF systems, so TTS from these sources is even less likely). TTS from explosives would be broadband. Tables 5a and 5b summarize the vocalization data for each species.
- 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) is 195 dB (SEL), which might be received at distances of up to 140 m from the most powerful MFAS source, the AN/SQS–53 (the maximum ranges to TTS from other sources would be less, as modeled for MIRC). 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 watchstanders and the nominal speed of an active sonar vessel (10–12 knots). In the TTS studies, some using exposures of almost an hour in duration or up to 217 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)—In the TTS laboratory studies, some using exposures of almost an hour in duration or up to 217 SEL, almost all individuals 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 MFAS/HFAS training exercises in MIRC, it is unlikely that marine mammals would ever 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 because of short duration of the majority of the exercises and the speed of a typical vessel), if that. 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 is 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 most 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 (see Tables 5a and 5b). If impaired, marine mammals would typically be aware of their impairment and implement behaviors to compensate for it (see Communication Impairment Section), though these compensations may incur energetic costs.

Acoustic Masking or Communication Impairment

Table 5 is also informative regarding the nature of the masking or communication impairment that could potentially occur from MFAS (again, center frequencies are 3.5 and 7.5 kHz for the two types of hull-mounted active sonar). However, masking only occurs during the time of the signal (and potential secondary arrivals of indirect rays), versus TTS, which continues beyond the duration of the signal. Standard MFAS pings last on average one second and occur about once every 24–30 seconds for hull-mounted sources. For the sources for which we know the pulse length, most are significantly shorter than hull-mounted active sonar, on the order of several microseconds to 10s of micro seconds. For hull-mounted active sonar, though some of the vocalizations that marine mammals make are less than one second long, there is only a 1 in 24 chance that they would occur exactly when the ping was received, and when vocalizations are longer than one second, only parts of them are masked. Alternately, when the pulses are only several microseconds long, the majority of most animals' vocalizations would not be masked. Masking effects from MFAS/HFAS 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 signal length, frequency, and duty cycle of the MFAS/HFAS signal does not perfectly mimic the characteristics of any marine mammal's vocalizations.

PTS, Injury, or Mortality

The Navy's model estimated that one pantropical dolphin and one sperm whale would be exposed to levels of MFAS/HFAS that would result in PTS. This estimate does not take into consideration either the mitigation measures, the likely avoidance behaviors of some of the animals exposed, the distance from the sonar dome of a surface vessel within which an animal would have to be exposed to incur PTS (10 m), and the nominal speed of a surface vessel engaged in ASW exercises. NMFS believes that many marine mammals would deliberately avoid exposing themselves to the received levels of active sonar necessary to induce injury by moving away from or at least modifying their path to avoid a close approach.

Additionally, in the unlikely event that an animal approaches the sonar vessel at a close distance, NMFS believes that the mitigation measures (i.e., shutdown/powerdown zones for MFAS/HFAS) would typically ensure that animals would be not be exposed to injurious levels of sound. As discussed previously, the Navy utilizes both aerial (when available) and passive acoustic monitoring (during all ASW exercises) in addition to watchstanders on vessels to detect marine mammals for mitigation implementation and indicated that they are capable of effectively monitoring a 1000-meter (1093-yd) safety zone at night using night vision goggles, infrared cameras, and passive acoustic monitoring.

If a marine mammal is able to approach a surface vessel within the distance necessary to incur PTS, the likely speed of the vessel (nominal 10–12 knots) would make it very difficult for the animal to remain in range long enough to accumulate enough energy to result in more than a mild case of PTS. As mentioned previously and in relation to TTS, the likely consequences to the health of an individual that incurs PTS can range from mild to more serious dependent upon the degree of PTS and the frequency band it is in, and many animals are able to compensate for the shift, although it may include energetic costs. While NMFS believes it is very unlikely that a pantropical dolphin or sperm whale will incur PTS from exposure to MFAS/HFAS, the Navy has requested authorization to take one each by Level A Harasssment and therefore, NMFS has considered this possibility in our analysis.

As discussed previously, marine mammals (especially beaked whales) could potentially respond to MFAS at a received level lower than the injury threshold in a manner that indirectly results in the animals stranding. The exact mechanisms of this potential response, behavioral or physiological, are not known. When naval exercises have been associated with strandings in the past, it has typically been when three or more vessels are operating simultaneously, in the presence of a strong surface duct, and in areas of constricted channels, semi-enclosed areas, and/or steep bathymetry. While these features certainly do not define the only factors that can contribute to a stranding, and while they need not all be present in their aggregate to increase the likelihood of a stranding, it is worth noting that they are not all present in the MIRC, which does have a strong surface duct present much of the time, but does not have bathymetry or constricted channels of the type that have been present in the sonar-associated strandings. Additionally, based on the number of occurrences where strandings have been definitively associated with military active sonar versus the number of hours of active sonar training that have been conducted, we suggest that the probability is small that this will occur. Additionally, an active sonar shutdown protocol for strandings involving live animals milling in the water minimizes the chances that these types of events turn into mortalities. Though NMFS does not expect it to occur, because of the uncertainty surrounding the mechanisms that link exposure to MFAS to stranding (especially in beaked whales), NMFS is proposing to authorize the injury or mortality of 10 beaked whales over the course of the 5-yr regulations.

60 Years of Navy Training Exercises Using MFAS/HFAS in the MIRC Range Complex

The Navy has been conducting MFAS/HFAS training exercises in the MIRC Range Complex for over 60 years. Although limited monitoring specifically in conjunction with training exercises to determine the effects of active sonar and explosives on marine mammals has not been conducted by the Navy in the past in the MIRC and the symptoms indicative of potential acoustic trauma were not as well recognized prior to the mid-nineties, people have been collecting stranding data in the MIRC Range Complex for approximately 4 years. Though not all dead or injured animals are expected to end up on the shore (some may be eaten or float out to sea), one might expect that if marine mammals were being harmed by the Navy training exercises with any regularity, more evidence would have been detected.

Species-Specific Analysis

In the discussions below, the ''acoustic analysis'' refers to the Navy's analysis, which includes the use of several models and other applicable calculations as described in the Estimates of Potential Marine Mammal Exposure section. The numbers predicted by the ''acoustic analysis'' are based on a uniform and stationary distribution of marine mammals and do not take into consideration the implementation of mitigation measures or potential avoidance behaviors of marine mammals, and therefore, are likely overestimates of potential exposures to the indicated thresholds (PTS, TTS, behavioral harassments).

Blue Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that 130 exposures of blue whales to MFAS/HFAS at levels likely to result in Level B harassment will occur, and that 0 exposures to explosives will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although two TTS takes are also estimated. However, it is unlikely that any blue whales will incur TTS because of: the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size, average group size (2–3), and pronounced vertical blow) and implement active sonar powerdown or shutdown. Of note, blue whale vocalizations are in the 12 to 400 Hz range with dominant energy in the 12 to 25 Hz range, which suggests that blue whale hearing may be more sensitive in this frequency range. Thus, frequencies in the MFAS range (1–10 kHz) are predicted to lie closer to the periphery of their hearing, which suggests that adverse impacts resulting from exposure to MFAS may be fewer than modeled.

Blue whales have not actually been seen in the MIRC and the most appropriate population estimate is the one for the North Pacific, which estimates a minimum of 3,300 whales. Like most baleen whales, blue whales would most likely feed in the north in the summer and head southward (potentially MIRC) in the cooler months. Relative to the population size, this activity is anticipated to result only in a limited number of level B harassment takes. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. The blue whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of blue whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Fin Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that 182 exposures of fin whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 0 exposures to explosives will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although two TTS takes are also estimated. However, it is unlikely that any fin whales will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size, average group size (3), and pronounced vertical blow) and implement active sonar powerdown or shutdown. Of note, fin whale vocalizations are in the 15–750 Hz range with the majority below 70 Hz, which suggests that fin whale hearing may be more sensitive in this frequency range. Thus, frequencies in the MFAS range (1–10 kHz) are predicted to lie closer to the periphery of their hearing, which suggests that adverse impacts resulting from exposure to MFAS may be fewer than modeled.

Fin whales have not actually been seen in the MIRC and the most appropriate population estimate is the one for the North Pacific, which estimates 14,620–18,630 whales. Relative to the population size, this activity is anticipated to result only in a limited number of level B harassment takes. In the northern hemisphere, fin whales migrate seasonally from high Arctic feeding areas in the summer to low latitude breeding and calving areas in the winter. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. The fin whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of fin whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Sei Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that 325 exposures of sei whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 0 exposures to explosives will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although six TTS takes are also estimated. However, it is unlikely that any sei whales will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size, average group size (3), and pronounced vertical blow) and implement active sonar powerdown or shutdown.

The most appropriate population estimate for the sei whale is the one for the North Pacific, which estimates 9,110 whales. Relative to the population size, this activity is anticipated to result only in a limited number of level B harassment takes. Sei whales are generally thought to feed in the summer in the north and spend winters in warm temperate or sub-tropical areas. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. The sei whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of sei whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Humpback Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that 804 exposures of humpback whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although ten TTS takes are also estimated. However, it is unlikely that any humpback whales will incur TTS because of: the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size and gregarious nature) and implement active sonar powerdown or shutdown.

The acoustic analysis further predicts that 1 humpback whale would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS. NMFS believes that this is unlikely because of: (1) The distance within which they would have to approach the explosive source; and, (2) the likelihood that Navy monitors would, during pre- or during exercises monitoring, detect these large, gregarious animals prior to an approach within this distance and require a delay of the exercise.

The current estimate for the North Pacific is 18,302 humpback whales. Relative to the population size, this activity is anticipated to result only in a limited number of level B harassment takes. Humpback whales are generally thought to feed in the summer in the north and spend winters in warm temperate or sub-tropical areas. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. The humpback whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of humpback whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Bryde's Whale

Acoustic analysis predicts that 457 exposures of Bryde's whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 0 exposures to explosives will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although 8 TTS takes are also estimated. However, it is unlikely that any fin whales will incur TTS because of: the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size and pronounced blow) and implement active sonar powerdown or shutdown.

Bryde's whales are found worldwide in tropical and temperate waters. There are no current estimates of Bryde's whale in the Pacific but based on the MISTCS survey, abundance in MIRC is about 233 animals. Historical records show a consistent presence of Bryde's whales in the MIRC. Bryde's whales have been sighted with calves several times, but no regularly used reproductive areas have been identified. The Bryde's whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of Bryde's whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Minke Whale

Acoustic analysis predicts that 445 exposures of Minke whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 0 exposures to explosives will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although 7 TTS takes are also estimated. It is somewhat unlikely that any fin whales will incur TTS because of: the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS) and the fact that many animals will likely avoid active sonar sources to some degree. However, Minke whales are relatively cryptic at surface, making visual detection more difficult, although they are often detected acoustically.

Minke whales are found in the North Atlantic and North Pacific from tropical to polar waters, although there are no current estimates of Minke whales in the Pacific. Minke whales were the most frequently detected species of baleen whales in the MISTCS (acoustically, not visually). The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of Minke whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Sperm Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that 817 exposures of sperm whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although 10 TTS takes and 1 PTS (Level A Harassment) are also estimated and proposed for authorization. However, it is unlikely that any sperm whales will incur TTS or PTS because of: The distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS and 10 m for PTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their large size, pronounced blow, and mean group size of 7).

The acoustic analysis further predicts that 9 sperm whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS. NMFS believes that this is unlikely because of: (1) The distance within which they would have to approach the explosive source; and, (2) the likelihood that Navy monitors would, during pre- or during exercises monitoring, detect these animals for the reasons indicated above.

Sperm whales occur throughout all ocean basins from equatorial to polar waters. Sperm whales are found throughout the North Pacific, but there are no current estimates of sperm whale abundance in the North Pacific, but based on the MISTCS survey, abundance in MIRC is about 705 animals. The sperm whale was the most frequently sighted cetacean in the MISTCS and was acoustically detected 3 times more often than it was visually detected. Sperm whales are present year-round in MIRC and have been sighted with calves, although no regularly used reproductive areas have been identified. The Sperm whales' large size and detectability makes it unlikely that these animals would be exposed to the higher levels of sound expected to result in more severe effects. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of sperm whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Pygmy and Dwarf Sperm Whale

Because of their similarity of appearance and cryptic behavior, these two species are difficult to differentiate in the field and are considered together. Acoustic analysis predicts that 6,677 exposures of pygmy or dwarf sperm whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B

Harassment section, although 103 TTS takes are also estimated. NMFS believes that it is unlikely that this number of pygmy or dwarf sperm whales will incur TTS because of the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS) and the fact that many animals will likely avoid active sonar sources to some degree. However, the likelihood that Navy monitors would detect most of these animals at the surface prior to an approach within this distance is low because of their small size, non-gregarious nature, and cryptic behavior and profile. As mentioned above and indicated in Table 5, some pygmy or dwarf sperm whale vocalizations might overlap with the MFAS/HFAS TTS frequency range (2–20 kHz) (although most of their vocalizations are anticipated to be in a higher frequency range), which could potentially temporarily decrease an animal's sensitivity to the calls of conspecifics or returning echolocation signals. However, as noted previously, NMFS does not anticipate TTS of a long duration or severe degree to occur as a result of exposure to MFAS/HFAS.

The acoustic analysis further predicts that 6 pygmy or dwarf sperm whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and 20 could be exposed to levels associated with behavioral disturbance.

Pygmy and dwarf sperm whales occur in tropical and temperate latitudes worldwide, although there are no current estimates of these whales in the Pacific or MIRC. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of dwarf or pygmy sperm whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Beaked Whales

Acoustic analysis predicts that 770 Blainville's beaked whales, 3,611 Cuvier's beaked whales, 430 Ginkgo-toothed beaked whales, and 206 Longman's beaked whales will be exposed to MFAS/HFAS at sound levels likely to result in Level B harassment. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although 12, 44, 7, and 2 (respectively) TTS takes are also estimated. NMFS believes that it is unlikely that this number of beaked whales will incur TTS because of the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS) and the fact that many animals will likely avoid active sonar sources to some degree. However, the likelihood that Navy monitors would detect most of these animals at the surface prior to an approach within this distance is low because of their deep-diving behavior and cryptic profile. As mentioned above and indicated in Table 5, some beaked whale vocalizations might overlap with the MFAS/HFAS TTS frequency range (2–20 kHzge), which could potentially temporarily decrease an animal's sensitivity to the calls of conspecifics or returning echolocation signals. However, as noted previously, NMFS does not anticipate TTS of a long duration or severe degree to occur as a result of exposure to MFAS/HFAS.

The acoustic analysis further predicts that 4 Cuvier's beaked whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and 14 could be exposed to levels associated with behavioral disturbance.

Cuvier's and Blainville's beaked whales are widespread throughout tropical and temperate latitudes worldwide, while Ginkgo-toothed and Longman's beaked whales are not well known, but thought to occur in the tropical and temperate waters of the Indo-Pacific. No abundance estimates are available for any of these species. The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of beaked whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on this species.

Social Pelagic Species (False/Pygmy Killer Whale, Killer Whale, Short-Finned Pilot Whale, and Melon-Headed Whale)

Acoustic analysis predicts that 1289 false killer whales, 230 killer whales, 2854 melon-headed whales, 160 pygmy killer whales, and 2274 short-finned pilot whales will be exposed to MFAS/HFAS at sound levels likely to result in Level B harassment. This estimate represents the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although 23, 4, 46, 2, and 36 (respectively) TTS takes are also estimated. However, it is unlikely that many individuals of these species will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their gregarious nature and large group size) and implement active sonar powerdown or shutdown. As mentioned above and indicated in Table 5, vocalizations of these species might overlap with the MFAS/HFAS TTS frequency range (2–20 kHz), which could potentially temporarily decrease an animal's sensitivity to the calls of conspecifics or returning echolocation signals. However, as noted previously, NMFS does not anticipate TTS of a long duration or severe degree to occur as a result of exposure to MFAS/HFAS.

The acoustic analysis further predicts that 2 melon-headed whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and 6 could be exposed to levels associated with behavioral disturbance. NMFS believes that this is unlikely because of: (1) The distance within which they would have to approach the explosive source; and, (2) the likelihood that Navy monitors would, during pre- or during exercises monitoring, detect these large-grouped gregarious animals prior to an approach within this distance and require a delay of the exercise.

These species all have large ranges, primarily tropical (melon-headed and pygmy killer whales) and tropical/temperate (false killer and short-finned pilot whales), although the killer whale is more abundant at higher latitudes. Abundance estimates are only available from the MISTCS and only for 3 species (melon-headed whales—2455, short-finned pilot whale—909, and false killer whale—637). The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of these social pelagic whales. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on these species.

Dolphins

Acoustic analysis predicts that individuals of all 8 of the dolphin species present in the MIRC will be exposed to MFAS/HFAS at sound levels likely to result in Level B harassment some number of times (see Table 8). These estimates represent the total number of takes and not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of a year. These Level B takes are anticipated to be primarily in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, although some number of TTS takes are also estimated for all species and one PTS take is predicted for a pantropical spotted dolphin. However, it is unlikely that many individuals of these species will incur TTS because of: the distance within which they would have to approach the MFAS source (approximately 140 m for the most powerful source for TTS), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these animals prior to an approach within this distance (given their gregarious nature and large group size) and implement active sonar powerdown or shutdown. However, the Navy's proposed mitigation has a provision that allows the Navy to continue operation of MFAS if the animals are clearly bow-riding even after the Navy has initially maneuvered to try and avoid closing with the animals. Since these animals sometimes bow-ride they could potentially be exposed to levels associated with TTS as they approach or depart from bow-riding. As mentioned above and indicated in Table 5, vocalizations of these species might overlap with the MFAS/HFAS TTS frequency range (2–20 kHz), which could potentially temporarily decrease an animal's sensitivity to the calls of conspecifics or returning echolocation signals. However, as noted previously, NMFS does not anticipate TTS of a long duration or severe degree to occur as a result of exposure to MFAS/HFAS.

The acoustic analysis further predicts that several individuals of several species of dolphins would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS or behavioral harassment. NMFS believes that this is unlikely because of: (1) The distance within which they would have to approach the explosive source; and, (2) the likelihood that Navy monitors would, during pre- or during exercises monitoring, detect these large-grouped gregarious animals prior to an approach within this distance and require a delay of the exercise.

These species all have large ranges, primarily tropical and tropical/temperate. Abundance estimates are only available from the MISTCS and only for 5 species (bottlenose dolphin—122, pantropical spotted dolphin—12,981, rough-toothed dolphin—166, spinner dolphin—1803, and striped dolphin—3531). Three species were sighted with calves during the MISTCS, bottlenose dolphins, Risso's dolphins, and striped dolphins, however, no areas of regular use for breeding or calving have been identified.

Spinner dolphins, which rest primarily during the day in relatively large groups, are known to consistently use certain areas (usually Bays) for this function. Because of this, they are a regular target for whalewatching boats or other members of the public interested in viewing or interacting with them, which could potentially put them at increased energetic risk if their resting cycles are repeatedly interrupted in a significant manner. There are several resting areas for spinner dolphins in the MIRC Study Area: Agat Bay, Bile/Tougan Bay, and Double Reef. These areas usually occur in clear, calm, shallow waters sheltered from prevailing tradewinds. NMFS and the Navy considered spinner dolphin resting areas in relation to areas where the Navy plans to conduct training activities, including the Agat Bay UNDET areas. The outermost edge of the resting areas extends out approximately .5 nm (900m) from shore, which is 4 nm (7.4km) away from the Agat Bay UNDET area. The estimated threshold range for TTS exposure from explosives ordnance used in the Agat Bay UNDET area is approximately .3nm (500m). Therefore, explosive activities conducted at this site are not expected to impact resting spinner dolphins. Unlike the UNDET areas for MIW, there are no areas specifically designated for ASW and SUW exercises. They are, however, all conducted at least 3nm (5.6km) away from shore and can occur anywhere throughout the 500,000nm ^{2} MIRC Study Area. The Agat Bay, Bile/Tougan, and Double Reef resting areas extend aproximately .5nm, .4nm, and .3nm from shore. The TTS threshold distance for MFA ranges from 0 to 140m from the source and, therefore, spinner dolphins resting in these Bays are not expected to be exposed to levels associated with TTS. The received SPL level at 2.5nm (4.6km), is between 160 and 170dB and there could be potential for some behavioral impacts if spinner dophins were resting in the area when ASW was conducted at the closest possible spot, however, due to the large size of the MIRC study area (over 500,000nm^2), the probability that ASW training activities would be conducted in close proximity to any of the recognized resting areas when spinner dolphins are present is very low.

The MIRC activities are not expected to occur in an area/time of specific importance for reproduction, feeding, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of dolphins. Based on the general information contained in the Negligible Impact Analysis section and this species-specific summary of the effects of the takes, NMFS has preliminarily determined that the Navy's specified activities will have a negligible impact on these species.

Preliminary Determination

Negligible Impact

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 Navy training exercises utilizing MFAS/HFAS and underwater explosives in the MIRC will have a negligible impact on the affected 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 that taking.

Subsistence Harvest of Marine Mammals

NMFS has preliminarily determined that the issuance of 5-year regulations and subsequent LOAs for Navy training exercises in the MIRC would not have an unmitigable adverse impact on the availability of the affected species or stocks for subsistence use.

As noted above, NMFS will consider all comments, suggestions and/or concerns submitted by the public during the proposed rulemaking comment period to help inform our final decision, particularly with respect to our negligible impact determination and the proposed mitigation and monitoring measures.

ESA

There are five marine mammal species and two sea turtle species that are listed as endangered under the ESA with confirmed or possible occurrence in the study area: humpback whale, sei whale, fin whale, blue whale, sperm whale, hawksbill sea turtle and leatherback sea turtle. An additional three species of sea turtles are also listed as threatened under the ESA: green sea turtle, loggerhead sea turtle, and olive ridley sea turtle. The Navy has begun consultation with NMFS and the USFWS pursuant to section 7 of the ESA, and NMFS will also consult internally on the issuance of LOAS under section 101(a)(5)(A) of the MMPA for MIRC activities. Consultation will be concluded prior to a determination on the issuance of the final rule and an LOA.

NEPA

NMFS has participated as a cooperating agency on the Navy's Draft Environmental Impact Statement (DEIS) for the MIRC, which was published on January 30, 2008. The Navy's DEIS is posted on NMFS' Web site: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.* NMFS intends to adopt the Navy's Final EIS (FEIS), if adequate and appropriate. Currently, we believe that the adoption of the Navy's FEIS will allow NMFS to meet its responsibilities under NEPA for the issuance of an LOA for MIRC. If the Navy's FEIS is deemed not to be adequate, NMFS would supplement the existing analysis to ensure that we comply with NEPA prior to the issuance of the final rule or LOA.

Classification

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

The Office of Management and Budget has determined that this proposed rule is 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 proposed rule, if adopted, would not have a significant economic impact on a substantial number of small entities. The Regulatory Flexibility Act 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 rulemaking, not a small governmental jurisdiction, small organization or small business, as defined by the Regulatory Flexibility Act (RFA). 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. NMFS does not expect the issuance of these regulations or the associated LOAs to result in any impacts to small entities pursuant to the RFA. 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.

List of Subjects in 50 CFR Part 218

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

Samuel D. Rauch III,

Deputy Administrator for Regulatory Programs, 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.*

Subparts D–K [Added and Reserved]

2. Subparts D–K are added to part 218 and reserved.

3. Subpart L is added to part 218 to read as follows:

Subpart L—Taking and Importing Marine Mammals; U.S. Navy's Mariana Islands Range Complex (MIRC)

Sec.

Subpart L—Taking and Importing Marine Mammals; U.S. Navy's Mariana Islands Range Complex (MIRC)

§ 218.100 Specified activity and geographical area.

(a) Regulations in this subpart apply only to the U.S. Navy for the taking of marine mammals that occurs 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) The taking of marine mammals by the Navy is only authorized if it occurs within the Mariana Islands Range Complex (MIRC) Study Area (as depicted in Figure 1–1 in the Navy's application for MIRC), which is bounded by a pentagon with the following five corners: 16°46′29.3376″ N. lat., 138°00′59.835″ E. long.; 20°02′24.8094″ N. lat., 140°10′13.8642″ E. long.; 20° 3′ 27.5538″ N. lat., 149° 17′ 41.0388″ E. long.; 7° 0′ 30.0702″ N. lat., 149° 16′ 14.8542''E. long; and 6° 59′ 24.633″ N. lat, 138° 1′ 29.7228″ E. long.

(c) The taking of marine mammals by the Navy is only authorized if it occurs incidental to the following activities within the designated amounts of use:

(1) The use of the following mid-frequency active sonar (MFAS) sources, high frequency active sonar (HFAS) sources for U.S. Navy anti-submarine warfare (ASW), in the amounts and in the locations indicated below (± 10%):

(i) AN/SQS–53 (hull-mounted active sonar)—up to 10865 hours over the course of 5 years (an average of 2173 hours per year), with no more than 10% of this use in the winter;

(ii) AN/SQS–56 (hull-mounted active sonar)—up to 705 hours over the course of 5 years (an average of 141 hours per year);

(iii) AN/SSQ–62 (Directional Command Activated Sonobuoy System

(DICASS) sonobuoys)—up to 8270 sonobuoys over the course of 5 years (an average of 1654 sonobuoys per year)

(iv) AN/AQS–22 (helicopter dipping sonar)—up to 2960 hours over the course of 5 years (an average of 592 hours per year);

(v) AN/BQQ–10 (submarine hull-mounted sonar)—up to 60 hours over the course of 5 years (an average of 12 hours per year);

(vi) MK–48, MK–46, or MK–54 (torpedoes)—up to 200 torpedoes over the course of 5 years (an average of 40 torpedoes per year);

(vii) AN/SSQ–110 (IEER)—up to 530 buoys deployed over the course of 5 years (an average of 106 per year);

(viii) AN/SSQ–125 (AEER)—up to 530 buoys deployed over the course of 5 years (an average of 106 per year);

(ix) Range Pingers—up to 1400 hours over the course of 5 years (an average of 280 hours per year); and

(x) PUTR Transponder—up to 1400 hours over the course of 5 years (an average of 280 hours per year).

(2) The detonation of the underwater explosives indicated in paragraph (c)(2)(i) of this section conducted as part of the training events indicated in paragraph (c)(2)(ii) of this section:

(i) Underwater Explosives:

(A) 5″ Naval Gunfire (9.5 lbs);

(B) 76 mm rounds (1.6 lbs);

(C) Maverick (78.5 lbs);

(D) Harpoon (448 lbs);

(E) MK–82 (238 lbs);

(F) MK–83 (574 lbs);

(G) MK–84 (945 lbs);

(H) MK–48 (851 lbs);

(I) Demolition Charges (10 lbs);

(J) AN/SSQ–110A (IEER explosive sonobuoy—5 lbs);

(K) Hellfire (16.5lbs);

(L) GBU 38/32/31.

(ii) Training Events:

(A) Gunnery Exercises (S–S GUNEX)—up to 60 exercises over the course of 5 years (an average of 12 per year);

(B) Bombing Exercises (BOMBEX)—up to 20 exercises over the course of 5 years (an average of 4 per year);

(C) Sinking Exercises (SINKEX)—up to 10 exercises over the course of 5 years (an average of 2 per year);

(D) Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) Systems—up to 530 deployments over the course of 5 years (an average of 106 per year);

(E) Demolitions—up to 50 over the course of 5 years (an average of 10 per year); and

(F) Missile exercises (A–S MISSILEX)—up to 10 exercises over the course of 5 years (an average of 2 per year).

§ 218.101 [Reserved]

§ 218.102 Permissible methods of taking.

(a) Under Letters of Authorization issued pursuant to §§ 216.106 and 218.107 of this chapter, the Holder of the Letter of Authorization (hereinafter ''Navy'') may incidentally, but not intentionally, take marine mammals within the area described in § 218.100(b), provided the activity is in compliance with all terms, conditions, and requirements of these regulations and the appropriate Letter of Authorization.

(b) The incidental take of marine mammals under the activities identified in § 218.100(c) is limited to the following species, by the indicated method of take and the indicated number of times (estimated based on the authorized amounts of sound source operation):

(1) Level B Harassment (+/−10% of the take estimate indicated below):

(i) Mysticetes:

(A) Humpback whale (*Megaptera novaeangliae*)—4025 (an average of 805 annually);

(B) Fin whale (*Balaenoptera physalus*)—910 (an average of 182 annually);

(C) Blue whale (*Balaenoptera musculus*)—650 (an average of 130 annually);

(D) Sei whale (*Balaenoptera borealis)*—1625 (an average of 325 annually);

(E) Minke whale (*Balaenoptera acutorostrata*)—2225 (an average of 445 annually);

(F) Bryde's whale (*Balaenoptera edeni*)—2285 (an average of 457 annually); and

(G) Unidentified Baleanopterid whales—360 (an average of 72 annually)

(ii) Odontocetes:

(A) Sperm whales (*Physeter macrocephalus*)—4130 (an average of 826 annually);

(B) Killer whale (*Orcinus orca*)—1150 (an average of 230 annually);

(C) Pygmy or dwarf sperm whales (*Kogia breviceps or Kogia sima*)—33515 (an average of 6703 annually);

(D) Blainville's beaked whales (Mesoplodon densirostris);—3850 (an average of 770 annually);

(E) Cuvier's beaked whales (*Ziphius cavirostris*)—18135 (an average of 3627 annually);

(F) Ginkgo-toothed beaked whales (*Mesoplodon ginkgodens*)—2150 (an average of 430 annually);

(G) Longman's beaked whale (Indopacetus pacificus)—1030 (an average of 206 annually);

(H) Short-finned pilot whale (*Globicephala macrorynchus*)—11370 (an average of 2274 annually);

(I) Melon-headed whale (*Peponocephala electra*)—14310 (an average of 2862 annually)

(J) Pygmy killer whale (*Feresa attenuata*)—800 (an average of 160 annually);

(K) False killer whale (*Pseudorca crassidens*)—6445 (an average of 1289 annually);

(L) Striped dolphin (*Stenella coeruleoalba*)—44280 (an average of 8856 annually);

(M) Short-beaked common dolphin (*Delphinus delphis*)—4715 (an average of 943 annually);

(N) Risso's dolphin (*Grampus griseus*)—33855 (an average of 6771 annually);

(O) Bottlenose dolphin (*Tursiops truncates*)—855 (an average of 171 annually);

(P) Fraser's dolphin (*Lagenodelphis hosei*)—23065 (an average of 4613 annually);

(Q) Pantropical spotted dolphin (*Stenella attenuata*)—162465 (an average of 32493 annually);

(R) Rough-toothed dolphin (*Steno bredanensis*)—1205 (an average of 241 annually);

(S) Spinner dolphin (*Stenella longirostris*)—10715 (an average of 2143 annually); and

(T) Unidentified delphinid—7690 (an average of 1538 annually).

(2) Level A Harassment:

(i) Sperm whale—5 (an average of 1 annually);

(ii) Pantropical spotted dolphin—5 (an average of 1 annually);

(3) Level A Harassment and/or mortality of no more than 10 beaked whales (total), of any of the species listed in § 218.102(c)(1)(ii)(D) through (G) over the course of the 5-year regulations.

§ 218.103 Prohibitions.

No person in connection with the activities described in § 218.100 may:

(a) Take any marine mammal not specified in § 218.102(c);

(b) Take any marine mammal specified in § 218.102(c) other than by incidental take as specified in § 218.102(c)(1), (c)(2), and (c)(3);

(c) Take a marine mammal specified in § 218.102(c) 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 and 218.107 of this chapter.

§ 218.104 Mitigation.

(a) When conducting training and utilizing the sound sources or explosives identified in § 218.100(c), the mitigation measures contained in a Letter of Authorization issued under §§ 216.106 and 218.107 of this chapter must be implemented. These mitigation measures include, but are not limited to:

(1) Personnel Training:

(i) All commanding officers (COs), executive officers (XOs), lookouts, Officers of the Deck (OODs), junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews shall complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). All bridge lookouts shall complete both parts one and two of the MSAT; part two is optional for other personnel.

(ii) Navy lookouts shall undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968–D).

(iii) Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced lookout. Following successful completion of this supervised training period, lookouts shall complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). Personnel being trained as lookouts can be counted among required lookouts as long as supervisors monitor their progress and performance.

(iv) Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

(v) All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.

(vi) All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of MFAS/HFAS.

(2) General Operating Procedures (for all training types):

(i) Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order shall be issued to further disseminate the personnel training requirement and general marine species protective measures.

(ii) COs shall make use of marine species detection cues and information to limit interaction with marine mammals to the maximum extent possible consistent with safety of the ship.

(iii) While underway, surface vessels shall have at least two lookouts with binoculars; surfaced submarines shall have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals.

(iv) On surface vessels equipped with a multi-function active sensor, pedestal mounted ''Big Eye'' (20x110) binoculars shall be properly installed and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

(v) Personnel on lookout shall employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968–D).

(vi) After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968–D).

(vii) While in transit, naval vessels shall be alert at all times, use extreme caution, and proceed at a ''safe speed'', which means the speed at which the CO can maintain crew safety and effectiveness of current operational directives, so that the vessel can take action to avoid a collision with any marine mammal.

(viii) When marine mammals have been sighted in the area, Navy vessels shall increase vigilance and take all reasonable actions to avoid collisions and close interaction of naval assets and marine mammals. Such action may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

(ix) Navy aircraft participating in exercises at-sea shall conduct and maintain surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

(x) All marine mammal detections shall be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate when it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

(3) Operating Procedures (for Anti-submarine Warfare Operations):

(i) On the bridge of surface ships, there shall always be at least three people on watch whose duties include observing the water surface around the vessel.

(ii) All surface ships participating in ASW training events shall have, in addition to the three personnel on watch noted in paragraph (a)(3)(i) of this section, at least two additional personnel on watch as lookouts at all times during the exercise.

(iii) Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

(iv) Personnel on lookout shall be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine mammal that may need to be avoided.

(v) All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

(vi) During mid-frequency active sonar operations, personnel shall utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

(vii) Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.

(viii) Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

(ix) Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

(x) Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within or closing to inside 1,000 yds (914 m) of the sonar dome (the bow), the ship or submarine shall limit active transmission levels to at least 6 decibels (dB) below normal operating levels for that source (i.e., limit to at most 229 dB for AN/SQS–53C and 219 for AN/SQS–56C, etc.).

(A) Ships and submarines shall continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1000-yd exclusion zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

(B) Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active sonar transmissions shall be limited to at least 10 dB below the equipment's normal operating level (i.e., limit to at most 225 dB for AN/SQS–53C and 215 for AN/SQS–56C, etc.). Ships and submarines shall continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the 500-yd exclusion zone (at which point the 6-dB powerdown applies until the animal leaves the 1000-yd exclusion zone), has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

(C) Should the marine mammal be detected within or closing to inside 200 yds (183 m) of the sonar dome, active sonar transmissions shall cease. Sonar shall not resume until the animal has been seen to leave the 200-yd exclusion zone (at which point the 10-dB or 6-dB powerdowns apply until the animal leaves the 500-yd or 1000-yd exclusion zone, respectively), has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

(D) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the OOD concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

(xi) Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

(xii) Active sonar levels (generally)—Navy shall operate active sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

(xiii) Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving MFAS.

(xiv) If the need for power-down should arise (as detailed in § 218.114(a)(3)(x)) when the Navy was operating a hull-mounted or sub-mounted source above 235 db (infrequent), the Navy shall follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB active sonar was being operated).

(4) Operating Procedures for Underwater Detonations (up to 10-lb charges):

(i) Exclusion Zones—All demolitions and ship mine countermeasures training exercises involving the use of explosive charges must include exclusion zones for marine mammals to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site. Should a marine mammal be present within the the surveillance area, the explosive event shall not be started until the animal leaves the area.

(ii) Pre-Exercise Surveys—For Demolition and Ship Mine Countermeasures Operations, pre-exercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal. Should such an animal be present within the survey area, the explosive event shall not be started until the animal voluntarily leaves the area. The Navy will ensure the area is clear of marine mammals for a full 30 minutes prior to initiating the explosive event. Personnel will record any marine mammal observations during the exercise as well as measures taken if species are detected within the exclusion zone.

(iii) Post-Exercise Surveys—Surveys within the same exclusion zone radius shall also be conducted within 30 minutes after the completion of the explosive event.

(iv) Reporting—If there is evidence that a marine mammal may have been stranded, injured or killed by the action, Navy training activities shall be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to Commander, Pacific Fleet, Commander, Navy Region Northwest, Environmental Director, and the chain-of-command. The situation shall also be reported to NMFS (see Stranding Plan for details).

(5) Sinking Exercise:

(i) All weapons firing shall be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

(ii) An exclusion zone with a radius of 1.0 nm (1.9 km) will be established around each target. An additional buffer of 0.5 nm (0.9 km) will be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which will extend beyond the buffer zone by an additional 0.5 nm (0.9 km), would be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.

(iii) A series of surveillance over-flights shall be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol shall be as follows:

(A) Overflights within the exclusion zone shall be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

(B) All visual surveillance activities shall be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team will have completed the Navy's marine mammal training program for lookouts.

(C) In addition to the overflights, the exclusion zone shall be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE will be informed of any aural detection of marine mammals and will include this information in the determination of when it is safe to commence the exercise.

(D) On each day of the exercise, aerial surveillance of the exclusion and safety zones shall commence 2 hours prior to the first firing.

(E) The results of all visual, aerial, and acoustic searches shall be reported immediately to the OCE. No weapons launches or firing may commence until the OCE declares the safety and exclusion zones free of marine mammals.

(F) If a marine mammal is observed within the exclusion zone, firing will be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it can be assumed to have left the exclusion zone. The OCE will determine if the marine mammal is in danger of being adversely affected by commencement of the exercise.

(G) During breaks in the exercise of 30 minutes or more, the exclusion zone shall again be surveyed for any marine mammal. If marine mammals are sighted within the exclusion zone or buffer zone, the OCE shall be notified, and the procedure described above shall be followed.

(H) Upon sinking of the vessel, a final surveillance of the exclusion zone shall be monitored for 2 hours, or until sunset, to verify that no marine mammals were harmed.

(iv) Aerial surveillance shall be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean shall be used. These aircraft shall be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.

(v) Every attempt shall be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts shall be increased within the zones. This shall be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

(vi) The exercise shall not be conducted unless the exclusion zone and the buffer zone could be adequately monitored visually. Should low cloud cover or surface visibility prevent adequate visual monitoring as described previously, the exercise would be delayed until conditions improved, and all of the above monitoring criteria could be met.

(vii) In the event that any marine mammals are observed to be harmed in the area, a detailed description of the animal shall be taken, the location noted, and if possible, photos taken of the marine mammal. This information shall be provided to NMFS via the Navy's regional environmental coordinator for purposes of identification (see the draft Stranding Plan for detail).

(viii) An after action report detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event shall be submitted to NMFS.

(6) Surface-to-Surface Gunnery (up to 5-inch Explosive Rounds).

(i) For exercises using targets towed by a vessel, target-towing vessels shall maintain a trained lookout for marine mammals when feasible. If a marine mammal is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

(ii) A 600 yard (585 m) radius buffer zone will be established around the intended target.

(iii) From the intended firing position, trained lookouts will survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

(iv) The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within it.

(7) Surface-to-Surface Gunnery (non-explosive rounds)

(i) A 200-yd (183 m) radius buffer zone shall be established around the intended target.

(ii) From the intended firing position, trained lookouts shall survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable.

(iii) If available, target towing vessels shall maintain a lookout (unmanned towing vessels will not have a lookout available). If a marine mammal is sighted in the vicinity of the exercise, the tow vessel shall immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

(iv) The exercise shall be conducted only when the buffer zone is visible and marine mammals are not detected within the target area and the buffer zone.

(8) Surface-to-Air Gunnery (Explosive and Non-explosive Rounds).

(i) Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals.

(ii) Vessels will expedite the attempt to recover of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals.

(iii) Target towing aircraft shall maintain a lookout if feasible. If a marine mammal is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

(9) Air-to-Surface Gunnery (Explosive and Non-explosive Rounds).

(i) A 200 yard (183 m) radius buffer zone will be established around the intended target.

(ii) If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals to and during the exercise.

(iii) Aerial surveillance of the buffer zone for marine mammals will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 feet (152–456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited; aircraft must be able to actually see ordnance impact areas.

(iv) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(10) Small Arms Training (Grenades, Explosive and Non-explosive Rounds)—Lookouts will visually survey for marine mammals. Weapons will not be fired in the direction of known or observed marine mammals.

(11) Air-to-Surface At-sea Bombing Exercises (explosive bombs and rockets):

(i) If surface vessels are involved, trained lookouts shall survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed marine mammals.

(ii) A 1,000 yd (914 m) radius buffer zone shall be established around the intended target.

(iii) Aircraft shall visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area shall be made by flying at 1,500 ft (152 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the ‘‘wingman,’’ will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities.

(iv) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(12) Air-to-Surface At-Sea Bombing Exercises (Non-explosive Bombs and Rockets).

(i) If surface vessels are involved, trained lookouts will survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed marine mammals.

(ii) A 1,000 yard (914 m) radius buffer zone will be established around the intended target.

(iii) Aircraft will visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet (152 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the ''wingman,'' will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities.

(iv) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(13) Air-to-Surface Missile Exercises (explosive and non-explosive):

(i) Aircraft will visually survey the target area for marine mammals. Visual inspection of the target area will be made by flying at 1,500 (457 m) feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas.

(ii) Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals.

(14) Aircraft Training Activities Involving Non-Explosive Devices: Non-explosive devices such as some sonobuoys, inert bombs, and Mining Training Activities involve aerial drops of devices that have the potential to hit marine mammals if they are in the immediate vicinity of a floating target. The exclusion zone (200 yd), therefore, shall be clear of marine mammals and around the target location. Pre- and post-surveillance and reporting requirements outlined for underwater detonations shall be implemented during Mining Training Activities.

(15) Extended Echo Ranging/Improved Extended Echo Ranging (EER/IEER):

(i) Crews shall conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search shall be conducted at an altitude below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.

(ii) Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

(iii) For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 914 m (1,000 yd) of observed marine mammal activity, the Navy shall deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 914 m (1,000 yd) of the intended post position, the Navy shall co-locate the explosive source sonobuoy (AN/SSQ–110A) (source) with the receiver.

(iv) When operationally feasible, Navy crews shall conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of RF range of these sensors.

(v) Aural Detection—If the presence of marine mammals is detected aurally, then that shall cue the Navy aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

(vi) Visual Detection—If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ–110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety buffer. Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety buffer.

(vii) Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the ''Payload 1 Release'' command followed by the ''Payload 2 Release'' command. Aircrews shall refrain from using the ''Scuttle'' command when two payloads remain at a given post. Aircrews will ensure that a 914 m (1,000 yd) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

(viii) Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

(ix) The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ–110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

(x) Mammal monitoring shall continue until out of own-aircraft sensor range.

(16) The Navy shall abide by the letter of the ''Stranding Response Plan for Major Navy Training Exercises in the MIRC'' (available at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm*), which is incorporated herein by reference, to include the following measures:

(i) Shutdown Procedures—When an Uncommon Stranding Event (USE—defined in § 216.271) occurs during a Major Training Exercise (MTE) (as defined in the Stranding Plan, meaning including Multi-strike group exercises, Joint Expeditionary exercises, and Marine Air Ground Task Force exercises in the MIRC), the Navy shall implement the procedures described below.

(A) The Navy shall implement a Shutdown (as defined in the Stranding Response Plan for MIRC) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the MIRC Stranding Communication Protocol that a USE (as defined in the Stranding Response Plan for MIRC) involving live animals has been identified and that at least one live animal is located in the water. NMFS and Navy shall communicate, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(B) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(C) If the Navy finds an injured or dead marine mammal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. 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(s) is/are dead), location, time of first discovery, observed behaviors (if alive), and photo or video of the animals (if available). Based on the information provided, NMFS shall determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(D) In the event, following a USE, that: (a) Qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or (b) animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy shall coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS/HFAS activities or explosive detonations, though farther than 14 nm from the distressed animal(s), is likely decreasing the likelihood that the animals return to the open water. If so, NMFS and the Navy shall further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate.

(ii) Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the MIRC Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using MFAS/HFAS, and marine mammal sightings information associated with training activities occurring within 80 nm (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80 nm (148 km), 72 hours, period prior to the event shall be provided as soon as it becomes available. The Navy shall provide NMFS investigative teams with additional relevant unclassified information as requested, if available.

(iii) Memorandum of Agreement (MOA)—The Navy and NMFS shall develop a MOA, or other mechanism, that will establish a framework whereby the Navy can (and provide the Navy examples of how they can best) assist NMFS with stranding investigations in certain circumstances.

(b) [Reserved]

§ 218.105 Requirements for monitoring and reporting.

(a) *General notification of injured or dead marine mammals.* Navy personnel shall ensure that NMFS is notified immediately ((see Communication Plan) or as soon as clearance procedures allow) if an injured, stranded, or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. 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 of the animals (if available). In the event that an injured, stranded, or dead marine mammal is found by the Navy that is not in the vicinity of, or during or shortly after, MFAS, HFAS, or underwater explosive detonations, the Navy will report the same information as listed above as soon as operationally feasible and clearance procedures allow.

(b) *General notification of ship strike.* In the event of a ship strike by any Navy vessel, at any time or place, the Navy shall do the following:

(1) Immediately report to NMFS the species identification (if known), location (lat/long) of the animal (or the strike if the animal has disappeared), and whether the animal is alive or dead, or whether its status is unknown.

(2) Report to NMFS as soon as operationally feasible the size and length of animal, an estimate of the injury status (ex., dead, injured but alive, injured and moving, unknown, etc.), vessel class/type and operational status.

(3) Report to NMFS the vessel length, speed, and heading as soon as feasible.

(4) Provide NMFS a photo or video of the animal(s), if equipment is available

(c) The Navy must conduct all monitoring and/or research required under the Letter of Authorization including abiding by the MIRC Monitoring Plan. (*http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*)

(d) *Report on monitoring required in paragraph (c) of this section.* The Navy shall submit a report annually on November 15 describing the implementation and results (through June 1 of the same year) of the monitoring required in paragraph (c) of this section. Navy will standardize data collection methods across ranges to allow for comparison in different geographic locations.

(e) *Sonar exercise notification.* The Navy shall submit to the NMFS Office of Protected Resources (specific contact information to be provided in LOA) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any MTER indicating:

(1) Location of the exercise;

(2) Beginning and end dates of the exercise; and

(3) Type of exercise.

(f) *Annual MIRC Report.* The Navy will submit an Annual Exercise MIRC Report on November 15 of every year (covering data gathered through September 15). This report shall contain the subsections and information indicated below.

(1) MFAS/HFAS Major Training Exercises—This section shall contain the following information for the following Coordinated and Strike Group exercises, which for simplicity will be referred to as major training exercises for reporting (MTERs): Joint Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force MIRC:

(i) Exercise Information (for each MTER):

(A) Exercise designator;

(B) Date that exercise began and ended;

(C) Location;

(D) Number and types of active sources used in the exercise;

(E) Number and types of passive acoustic sources used in exercise;

(F) Number and types of vessels, aircraft, etc., participating in exercise;

(G) Total hours of observation by watchstanders;

(H) Total hours of all active sonar source operation;

(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)); and

(J) Wave height (high, low, and average during exercise).

(ii) Individual marine mammal sighting info (for each sighting in each MTER):

(A) Location of sighting;

(B) Species (if not possible—indication of whale/dolphin/pinniped);

(C) Number of individuals;

(D) Calves observed (y/n);

(E) Initial Detection Sensor;

(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG);

(G) Length of time observers maintained visual contact with marine mammal(s);

(H) Wave height (in feet);

(I) Visibility;

(J) Sonar source in use (y/n);

(K) Indication of whether animal is <200yd, 200–500yd, 500–1000yd, 1000–2000yd, or >2000yd from sonar source in § 218.104(a)(3)(x);

(L) Mitigation Implementation—Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was;

(M) If source in use in § 218.104(a)(3)(x) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel); and

(N) Observed behavior—Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(iii) An evaluation (based on data gathered during all of the MTERs) of the effectiveness of mitigation measures designed to avoid exposing marine mammals to MFAS. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary—This section shall include the following information as summarized from non-major training exercises (unit-level exercises, such as TRACKEXs):

(i) Total Hours—Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.))

(ii) Cumulative Impacts—To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major training (i.e., ULT) utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across MIRC. The Navy shall include (in the MIRC annual report) a brief annual progress update on the status of the development of an effective and unclassified method to report this information until an agreed-upon (with NMFS) method has been developed and implemented.

(3) Sinking Exercises (SINKEXs)—This section shall include the following information for each SINKEX completed that year:

(i) Exercise Info:

(A) Location;

(B) Date and time exercise began and ended;

(C) Total hours of observation by watchstanders before, during, and after exercise;

(D) Total number and types of rounds expended/explosives detonated;

(E) Number and types of passive acoustic sources used in exercise;

(F) Total hours of passive acoustic search time;

(G) Number and types of vessels, aircraft, etc., participating in exercise;

(H) Wave height in feet (high, low and average during exercise); and

(I) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted.

(ii) Individual marine mammal observation during SINKEX (by Navy lookouts) information:

(A) Location of sighting;

(B) Species (if not possible—indication of whale/dolphin/pinniped);

(C) Number of individuals;

(D) Calves observed (y/n);

(E) Initial detection sensor;

(F) Length of time observers maintained visual contact with marine mammal;

(G) Wave height;

(H) Visibility;

(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after;

(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated)—use four categories to define distance:

(*1*) The modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (TBD m for SINKEX in MIRC);

(*2*) The required exclusion zone (1 nm for SINKEX in MIRC);

(*3*) The required observation distance (if different than the exclusion zone (2 nm for SINKEX in MIRC); and

(*4*) Greater than the required observed distance. For example, in this case, the observer shall indicate if < TBD m, from 426 m–1 nm, from 1 nm–2 nm, and > 2 nm.

(K) Observed behavior—Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.

(L) Resulting mitigation implementation—Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.

(M) If observation occurs while explosives are detonating in the water, indicate munitions type in use at time of marine mammal detection.

(4) Improved Extended Echo-Ranging System (IEER) Summary:

(i) Total number of IEER events conducted in MIRC;

(ii) Total expended/detonated rounds (buoys); and

(iii) Total number of self-scuttled IEER rounds.

(5) Explosives Summary—The Navy is in the process of improving the methods used to track explosive use to provide increased granularity. To the extent practicable, the Navy shall provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(i) Total annual number of each type of explosive exercise (of those identified as part of the ''specified activity'' in this final rule) conducted in MIRC; and

(ii) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type.

(g) *MIRC 5-Yr Comprehensive Report.* The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual MIRC Exercise Reports and MIRC Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2013), covering activities that have occurred through July 15, 2014.

(h) *Comprehensive National ASW Report.* By June, 2014, the Navy shall submit a draft National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders and pursuant to the implementation of the Monitoring Plans for the Northwest Training Range Complex, the Southern California Range Complex, the Atlantic Fleet Active Sonar Training, the Hawaii Range Complex, the Marianas Islands Range Complex, and the Gulf of Alaska.

§ 218.106 Applications for Letters of Authorization.

To incidentally take marine mammals pursuant to these regulations, the U.S. Citizen (as defined by § 216.103 of this chapter) conducting the activity identified in § 218.100(c) (i.e., the Navy) must apply for and obtain either an initial Letter of Authorization in accordance with § 218.107 or a renewal under § 218.108.

§ 218.107 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 § 218.108.

(b) Each Letter of Authorization shall 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 shall 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).

§ 218.108 Renewal of Letters of Authorization and adaptive management.

(a) A Letter of Authorization issued under § 216.106 and § 218.177 of this chapter or 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 § 218.246 will 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) Receipt of the monitoring reports and notifications within the indicated timeframes required under § 218.105(b) through (j); and

(3) A determination by the NMFS that the mitigation, monitoring and reporting measures required under § 218.104 and the Letter of Authorization issued under §§ 216.106 and 218.107 of this chapter, 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 216.248 of this chapter indicates that a substantial modification, as determined by NMFS, 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. Review and 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) Adaptive Management—NMFS may modify or augment the existing mitigation or monitoring measures (after consulting with the Navy regarding the practicability of the modifications) 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 the MIRC Study Area or other locations).

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

(3) Compiled results of Navy funded research and development (R&D) studies (presented pursuant to the Integrated Comprehensive Monitoring Plan).

(4) Results from specific stranding investigations (either from the MIRC Study Area or other locations, and involving coincident MFAS/HFAS or explosives training or not involving coincident use).

(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).

§ 218.109 Modifications to Letters of Authorization.

(a) Except as provided in paragraph (b) of this section, no substantive modification (including withdrawal or suspension) to the Letter of Authorization by NMFS, issued pursuant to §§ 216.106 and 218.107 of this chapter 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 § 218.108, 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 § 218.100(b), a Letter of Authorization issued pursuant to §§ 216.106 and 218.107 of this chapter 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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