**DEPARTMENT OF COMMERCE**

**National Oceanic and Atmospheric Administration**

**50 CFR Part 218**

**[Docket No. 100817363–0365–02]**

**RIN 0648–BA14**

# Taking and Importing Marine Mammals; Military Training Activities Conducted Within the Gulf of Alaska (GoA) Temporary Maritime Activities Area (TMAA)

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

**ACTION:** Proposed rule; request for comments.

**SUMMARY:** NMFS has received a request from the U.S. Navy (Navy) for authorization to take marine mammals incidental to training activities conducted in the Gulf of Alaska (GoA) Temporary Maritime Activities Area (TMAA) for the period December 2010 through December 2015. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS proposes regulations to govern that take and requests information, suggestions, and comments on these proposed regulations. Specifically, we encourage the public to recommend effective, regionally specific methods for augmenting existing marine mammal density, distribution, and abundance information in the GoA TMAA and to prioritize the specific density and distribution data needs in the area (species, time of year, etc.). This information will ensure the design of the most effective Monitoring Plan with the resources available.

**DATES:** Comments and information must be received no later than November 18, 2010.

**ADDRESSES:** You may submit comments, identified by 0648–BA14, 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, Brian D. Hopper, or Michelle Magliocca, Office of Protected Resources, NMFS, (301) 713–2289.

**SUPPLEMENTARY INFORMATION:**

## Availability

A copy of the Navy's application, as well as the draft Monitoring Plan and the draft Stranding Response Plan for GoA TMAA, 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 GoA TMAA was published on December 11, 2009 and may be viewed at *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.* NMFS participates 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): 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 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 March 2009, NMFS received an application from the Navy requesting authorization to take individuals of 20 species of marine mammals (15 cetaceans and 5 pinnipeds) incidental to upcoming training activities to be conducted from December 2010 through December 2015 in the GoA TMAA, which is a 42,146 square nautical mile ($nm^2$) (145,482 $km^2$) polygon roughly the shape of a 300 nm (555.6 km) by 150 nm (277.8 km) rectangle oriented northwest to southeast in the long direction. NMFS subsequently requested additional information, which was provided in November 2009 in the form of a revised application. These training activities are classified as military readiness activities under the provisions of the NDAA of 2004. These military readiness activities may incidentally take marine mammals within the TMAA 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 20 species of cetaceans and pinnipeds by Level B Harassment. Further, although it does not anticipate that it will occur, the Navy requests authorization to take, by injury or mortality, up to 15 individual beaked whales (of any of the following species: Baird's beaked whale, Cuvier's beaked whale, Stejneger's beaked whale) over the course of the 5-year 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 naval systems.

The specified training activities addressed in this proposed rule are a subset of the Proposed Action described in the GoA TMAA DEIS, which would support and maintain Department of Defense training and assessments of current capabilities. Training does 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 GoA TMAA to:

- Increase the number of training activities from current levels (up to 14 days) as necessary to support Fleet exercise requirements (that could last up to 21 days between April and October);
- Conduct training in the Primary Mission Areas (PMARs) including Anti-Air Warfare (AAW), Anti-Surface Warfare (ASUW), Anit-Submarine Warfare (ASW), Naval Special Warfare (NSW), Strike Warfare (STW), and Electronic Combat (EC). Conduct of training may include that necessary for newer systems, instrumentation, and platforms, including the EA–18G Growler aircraft, Guided Missile Submarines (SSGN), P–8 Poseidon Multimission Maritime Aircraft (MMA), Guided Missile Destroyer (DDG) 1000 (Zumwalt Class) destroyer, and several types of Unmanned Aerial Systems (UASs);
- Accommodate training enhancement instrumentation, to include the use of a Portable Undersea Tracking Range (PUTR);
- Conduct an additional Carrier Strike Group (CSG) exercise during the months of April through October, which could also last up to 21 days (first CSG exercise being part of the baseline No Action Alternative); and
- Conduct a Sinking Exercise (SINKEX) during each summertime exercise (maximum of two) in the TMAA.

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:

- Helicopter Anti-submarine Warfare (ASW) tracking exercise (TRACKEX) (includes use of MFAS and HFAS dipping sonar and sonobuoys)
- Surface ASW TRACKEX (includes use of hull-mounted MFAS)
- Submarine ASW (includes use of hull-mounted MFAS and HFAS)
- Fixed-wing Marine Patrol Aircraft (MPA) ASW TRACKEX (includes use of sonobuoys)
- Extended Echo Ranging ASW (includes explosive sonobuoys)
- Bombing Exercises (BOMBEX)
- Sinking Exercises (SINKEX)
- Gunnery Exercises (GUNEX)

Overview of the GoA TMAA

Since the 1990s, the Navy has participated in a major joint training exercise that involves the Departments of the Navy, Army, Air Force, and Coast Guard participants reporting to a unified or joint commander who coordinates the activities planned to demonstrate and evaluate the ability of the services to engage in a conflict and carry out plans in response to a threat to national security. Previous exercises in the TMAA have occurred in the summer (April–October) timeframe due to the extreme cold weather and sea state conditions in the TMAA during the winter months. The areas making up the Alaska Training Areas (ATAs) (see figure 1–1 in the Navy's application) consist of 3 components: (1) TMAA; (2) U.S. Air Force over-land Special Use Airspace (SUA) and air routes over the GoA and State of Alaska; and (3) U.S. Army training lands.

Within the northeastern GoA, the TMAA is comprised of the 42,146 square nautical miles ($nm^2$) (145,482 square kilometer ($km^2$) of surface and subsurface area and 88,731 $nm^2$ (305,267 $km^2$)) of special use airspace (SUA) (not including the portion of Warning Area 612 [W–612] that falls outside of the TMAA). The TMAA is roughly rectangular and oriented from northwest to southeast, approximately 300 nautical miles (nm) (556 kilometer (km)) long by 150 nm (278 km) wide, situated south of Prince William Sound and east of Kodiak Island. With the exception of Cape Cleare on Montague Island located over 12 nm (22 km) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore.

The abyssal plain in the GoA gradually shoals from a 16,400 feet (ft) (5,000 meter (m)) depth in the southwestern GoA to less than 9,843 ft (3,000 m) in the northeastern expanses of the Gulf. Maximal depths exceed 22,965 ft (7,000 m) near the central Aleutian Trench along the continental slope south of the Aleutian Islands. Numerous seamounts, remnants of submarine volcanoes, are scattered across the central basin. Several of the seamounts rise to within a few hundred meters of the sea surface.

Ocean circulation in the GoA is defined by the cyclonic motion of the Pacific subpolar gyre (also referred to as the Alaska Gyre), which is composed of the North Pacific Current, the Alaska Current, and the Alaskan Stream. Circulation patterns along the shelf divide the region into the inner shelf (or Alaska Coastal Current domain), the mid-shelf, and the outer shelf including the shelf break (DoN, 2006). The center of the gyre is located at approximately 52 to 53 °N and 145 to 155 °W. Nearshore flow is dominated by the Alaskan Coastal Current and is less organized than the flow found along the shelf break and slope. The northwestern GoA also includes several prominent geological features that influence the regional oceanography. For example, Kayak Island extends 50 km across the continental shelf to the east of the Copper River. This island can deflect shelf waters farther offshore delivering high concentrations of suspended sediment to the outer shelf (DoN, 2006).

During winter months, intense circulation over the GoA produces easterly coastal winds and downwelling, both of which result in a well-mixed water column. During the summer, stratification develops due to decreased winds, increased freshwater discharge, and increased solar radiation. Under summer and fall conditions, the shelf waters are stratified with the upper water column temperatures at their maximum and salinities at their minimum. On longer time scales, there is evidence of interannual variation in the circulation patterns within the GoA. These variations result from the climatic variability of the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) (DoN, 2006).

Generally, two surface temperature regimes characterize the northern expanses of the GoA throughout the year. Relatively warm surface water occurs over the continental shelf, while colder water is found farther offshore beyond the shelf break. Thermal stratification remains weak until late May or June, then strong stratification persists through the summer months. As winds intensify in the fall, stratification dissipates, due to stronger vertical mixing and increased downwelling, surface waters sink along the coast, and the thermocline deepens throughout the region. Along the continental shelf and within the coastal fjords, waters are often highly stratified by both salinity and temperature; an intense thermocline occurs at approximately 82 ft (25 m). Farther offshore in the Alaskan Stream, maximal stratification occurs between depths of 328 ft to 984 ft (100 to 300 m) and is associated primarily with a permanent halocline in the GoA (DoN, 2006).

Specified Activities

As mentioned above, the Navy has requested MMPA authorization to take marine mammals incidental to training in the GoA TMAA 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 Air Combat Maneuvers (ACM), Visit Board Search and Seizure/Vessels of Interest (VBSS/VOI), Maritime Interdiction (MI), Chaff Exercises, Sea Surface Control (SSC), and Naval Special Warfare Insertion/Extraction exercises; however, these activities are primarily air or land 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 GoA TMAA, 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 training 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 sonar 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 only provides information about 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 frequency range classifications for active sonar: Low-frequency (LF), mid-frequency (MF), and high-frequency (HF).

MFAS, as defined in the Navy's GoA TMAA 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 mid-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 ASW training is necessary for sailors on ships and in strike groups to gain proficiency using MFAS. Moreover, if a strike group does not demonstrate MFAS proficiency, it cannot be certified as combat ready.

HFAS, as defined in the Navy's GoA TMAA 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, which are all short range applications. Training exercises in the GoA TMAA will include the use of HFAS.

Low-frequency sources operate below 1 kHz. Sonar in this frequency range is designed to detect extremely quiet diesel-electric submarines at ranges far beyond the capabilities of MFA sonars. Currently, there are only two ships in use by the Navy equipped with low-frequency sonar; both are ocean surveillance vessels operated by Military Sealift Command. While Surveillance Towed Array Sensor System (SURTASS) low-frequency active sonar was analyzed in a separate EIS/OEIS, use of low-frequency active sonar is not part of the planned training activities considered for the GoA TMAA.

*Acoustic Sources Used for ASW Exercises in the GoA TMAA*

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 sonars emit an omni-directional ping and then rapidly scan 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 and other sound sources employed during training exercises in the GoA TMAA are identified in Table 1.

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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-53 | 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) | 578 | Hours |
| AN/SQS-56 | 7.5 | 225 | 129 | 13° | 30° | Frigate (FFG) hullmounted sonar | ASW search, detection, & localization (approximately 120 pings per hour) | 52 | Hours |
| AN/AQS-13/22 | Classifed (MF) | Classified | 15 | Omni | Omni | Helicopter Dipping sonar | ASW search, detection, & localization (10 pings/dip, 30 seconds between pings), also used to represent AN/AQS-13 | 192 | Hours |
| AN/BQQ-10 | Classifed (MF) | Classified | Classified | Classified | Classified | Submarine hull-mounted sonar | ASW search and attack (approximately one ping per two hours when in use) | 48 | Hours |
| BQS-15 or BQQ-24 | Classifed (HF) | Classified | Classified | Classified | Classified | Submarine hull-mounted sonar | 20 pings per hours for 4 hours | 24 | 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) | 266 | Buoys |
| MK-48 torpedo sonar | Classified (>10) | Classified | 144 | Omni | Omni | Submarine (SSN) launched torpedo (used during SINKEX) | Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run | 2 | 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 5 lb charges) and expendable passive receiver sonobuoy | 110 | Buoys |
| AN/SSQ-125 (MAC) | 1 | Classified | 15 | Omni | Omni | MPA deployed | AN/SSQ-110A replacement. ASW system consists of active sonobuoy and expendable passive receiver sonobuoy. Phased introduction beginning in 2011. | Included in IEER above | Buoys |
| MK-84 Range Pingers | 12.9 or 37 (rare) | 194 | Ping dur. 15 msec / ping every 2 sec | 90° | Omni | Ships, submarines, weapons, targets, and UUV (8-10 knot platform) | 4 pingers max used during a PUTR 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. | 80 | Hours |
| SUS MK-84 | Selectable at 3.3 or 3.5 | 160 | Continuous | Omni | Omni | Sonobuoy | Expendable buoy deployed from aircraft and ships used as a signaling device to communicate with submarines. Operating life of 70 seconds. | 24 | Buoys |
| 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. | 80 | Hours |

**Table 1.** Active sonar sources in the GOA 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; MPA - Maritime Patrol Aircraft; UUV - Unmanned Underwater Vehicle.

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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. During an exercise, fixed-wing MPA may be used to deploy both active and passive sonobuoys to assist in locating and tracking submarines or ASW targets. Helicopters may also be used during an exercise to deploy both active and passive sonobuoys to assist in locating and tracking submarines or ASW targets, and to deploy dipping sonar. Submarines are equipped with both passive and active sonar sensors that may be used to locate and prosecute other submarines and/or surface ships during the exercise. The platforms and systems used in ASW exercises are identified below.

*Surface Ship Sonar*—A variety of surface ships participate in training events, including the Fast Frigate (FFG), the Guided Missile Destroyer (DDG), and the Guided Missile Cruiser (CG). These three classes of ships are equipped with active as well as passive tactical sonar 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 because 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 are classified but were modeled based on the required tactical training setting.

*Submarine Sonars*—Submarines use sonar (*e.g.,* AN/BQQ–10) 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 use high-frequency sonar (AN/BQS–15 or BQQ–24) for navigation safety, mine avoidance, and a fathometer that is not unlike a standard fathometer in source level or output. There is, at present, no mine training range in the GoA TMAA. Therefore, given their limited use and rapid attenuation as high frequency sources, the AN/BQS–15 and BQQ–24 are not expected to result in the take of marine mammals.

*Aircraft Sonar Systems*—Aircraft sonar systems that would operate in the GoA TMAA include sonobuoys from fixed and rotary-wing aircraft and dipping sonar from helicopters. 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 also generate active acoustic signals. Dipping sonar is an active or passive sonar device lowered by cable from 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. Helicopters and MPA (P–3 or P–8 in approximately 2013) may deploy sonobuoys in the GoA TMAA during ASW training exercises.

*Extended Echo Ranging/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 has two components: An AN/SSQ–110A Sonobuoy, which generates an explosive sound impulse; and a passive receiver sonobuoy (SSQ–77), which "listens" 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. In other words, the equipment is not retrieved after deployment and, once deployed, it can be remotely controlled. For example, 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. Sixteen to twenty SSQ–110A source sonobuoys may be used in a typical exercise. Both charges of each sonobuoy would be detonated independently during the course of the training. The first detonation would be for tactical reasons—to locate the submarine; and the second occurs when the sonobuoy is 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.

*Multistatic Active Coherent (MAC) system*–Formerly referred to as the Advanced Extended Echo Ranging (AEER) system, the proposed SSQ–125 MAC sonobuoy system is operationally similar to the existing EER/IEER system. The MAC system will use the same Air Deployed Active Receiver (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/SSQ–110A as an impulsive source for the active acoustic wave, the MAC 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 MAC system will be assumed to occur at 25 percent per year as follows: 2011—25 percent replacement; 2012—50 percent replacement; 2013—75 percent replacement; 2014—100 percent 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. With the exception of SINKEX, torpedoes will not be used in the GoA TMAA during the proposed training activities.

*Portable Undersea Tracking Range (PUTR)*—The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training in numerous locations. The system tracks submarines, surface ships, weapons, targets, and unmanned undersea vehicles and then distributes the data to a data processing and display system, either aboard ship or at a shore site. The PUTR may be deployed to support ASW or other training in the GoA TMAA. The PUTR would temporarily place hydrophones on the seafloor in areas 25–100 nm$^2$ (46.3–185.2 km$^2$) or smaller and provide high-fidelity feedback and scoring of crew performance during ASW training activities. No on-shore construction would take place. Seven electronics packages, each approximately 3 ft (0.9 m) long by 2 ft (0.6 m) in diameter, would be temporarily installed on the seafloor by a range boat. The anchors used to keep the electronics packages on the seafloor consist of either concrete or sand bags, each of which are approximately 1.5 ft-by-1.5 ft (0.45 m-by-0.45 m) and 300 pounds (136 kilograms). PUTR equipment can be recovered for maintenance or when training is completed. 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 12.93 kHz sine wave in pulses with a maximum duty cycle of 30 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 4 hours each of the 20 PUTR operating days per year. Total time operated would be 80 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 kHz, 17 kHz, or 40 kHz, at a source level of 190 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 20 days per year, for 4 hours each day of use. Total time operated would be 80 hours annually.

*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. Two ASW training target types may be used in the TMAA: The MK–30, which is recovered after each use and the MK–39 Expendable Mobile ASW Training Target (EMATT), which is not recovered. Under the proposed action, approximately 12 EMATTs may be expended annually during training in the TMAA. A small percentage of these EMATTS may be replaced by the more costly yet recoverable MK–30.

As described above, ASW training exercises are the primary type of exercises that utilize MFAS and HFAS sources in the GoA TMAA. Unit level tracking and torpedo ASW exercises may occur over the course of several days during the proposed training period in the GoA TMAA. Under the Navy's preferred alternative, in a single year the GoA TMAA may have two exercises lasting up to 21 days, both of which may involve one ASW unit (aircraft, ship, or submarine) versus one target (usually a MK–39 EMATT or live submarine). 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. Use of torpedoes is not a proposed activity in the TMAA, with the exception of SINKEX. 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 (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, dipping sonar, variable-depth sonar, and sonobuoys for tracking.

ASW training activities will take place during the summer months, in the form of one or two major exercises or focused activity periods. These exercises or activity periods would each last up to 21 days and consist of multiple component training activities. Unlike Navy Training activities in other areas, the GOA TMAA is not a Range Complex and as such, there are no other or ongoing small scale Navy Training activities conducted outside these activity periods. Descriptions of each ASW tracking exercise type are provided below.

*Helicopter ASW TRACKEX*

A helicopter ASW TRACKEX typically involves one or two MH–60R helicopters using both passive and active sonar for tracking submarine targets. For passive tracking, the MH–60R may deploy patterns of passive sonobuoys to receive underwater acoustic signals, providing the helicopter crew with locating information on the target. Active sonobuoys may also be used. An active sonobuoy, as in any active sonar system, emits an acoustic pulse that travels through the water, returning echoes if any objects, such as a submarine, are within the range of acoustic detection. For active sonar tracking, the MH–60R crew will rely primarily on its AQS–22 Dipping Sonar. The sonar is lowered into the ocean while the helicopter hovers within 50 ft (15m) of the surface. Similar to the active sonobuoy, the dipping sonar emits acoustic energy and receives any returning echoes, indicating the presence of an underwater object. Use of dipping sonar has the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

The target for this exercise is either an EMATT or live submarine which may be either nonevading and assigned to a specified track or fully evasive depending on the state of training of the helicopter crew. A Helicopter TRACKEX usually takes 2 to 4 hours. No torpedoes are fired during this exercise. A total of 192 AQS–22 "dips" annually were analyzed for potential acoustic impacts under the proposed training activities.

*MPA[1] ASW TRACKEX*

During these exercises, a typical scenario involves a single MPA dropping sonobuoys, from an altitude below 3,000 ft (914 m), into specific patterns designed for both the anticipated threat submarine and the specific water conditions. These patterns vary in size and coverage area based on anticipated threat and water

[1] MPA currently refers to the P–3C Orion aircraft. The P–8 Multi-Mission Maritime Aircraft is scheduled to replace the P–3C as the Navy's MPA.

conditions. Typically, passive sonobuoys will be used first, so the threat submarine is not alerted. Active sonobuoys will be used as required either to locate extremely quiet submarines or to further localize and track submarines previously detected by passive buoys. Use of sonobuoys has the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

The MPA will typically operate below 3,000 ft (914 m) to drop sonobuoys, will sometimes be as low as 400 ft (122 m), then may climb to several thousand feet after the buoy pattern is deployed. The higher altitude allows monitoring of the buoys over a much larger search pattern area. The target for this exercise is either an EMATT or live submarine, which may be either non-evading and assigned to a specified track or fully evasive depending on the state of training of the MPA. An MPA TRACKEX usually takes 2 to 4 hours. The annual use of a total of 266 DICASS sonobuoys was analyzed for potential acoustic impacts under the proposed training activities.

*EER/IEER ASW Training Exercises*

This is an at-sea flying exercise designed to train MPA crews in the deployment and use of the EER/IEER sonobuoy systems. This system uses the SSQ–110A as the signal source and the SSQ–77 as the receiver buoy. This activity differs from the MPA ASW TRACKEX in that the SSQ–110A sonobuoy uses two explosive charges per buoy for the acoustic source. Other active sonobuoys use an electrically generated "ping." Use of explosive sonobuoys has the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

A typical EER/IEER exercise lasts approximately 6 hours. The aircrew will first deploy 16 to 20 SSQ–110A sonobuoys and 16 to 20 passive sonobuoys in 1 hour. For the next 5 hours, the sonobuoy charges will be detonated, while the EER/IEER system analyzes the returns for evidence of a submarine. This exercise may or may not include a practice target. For potential acoustic impacts, the annual deployments of 40 SSQ–110 (two explosions per buoy) sonobuoys were analyzed under the proposed training activities.

In the future, the SSQ–125 MAC sonobuoy will be deployed in the GoA TMAA as a replacement for the SSQ–110 in EER/IEER exercises.

*ASW TRACKEX (Surface Ship)*

Surface ships operating in the GoA TMAA would use hull-mounted active sonar to conduct ASW Tracking exercises. Typically, this exercise would involve the coordinated use of other ASW assets, to include MPA, helicopters, and other ships. A total of 578 hours of SQS–53 and 52 hours of SQS–56 sonar annually were analyzed for potential acoustic impacts under the proposed training activities. Acoustic cumulative and synergistic effects are incorporated into the modeling as detailed in Appendix B of the Navy's LOA application (see **SUPPLEMENTARY INFORMATION** section for information on obtaining copies of supporting documents). Use of active sonar by surface ships for ASW has the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

*ASW or Anti-Surface Warfare (ASUW) (Submarine)*

During these exercises, submarines use passive sonar sensors to search, detect, classify, localize, and track the threat submarine with the goal of developing a firing solution that could be used to launch a torpedo and destroy the threat submarine. However, no torpedoes are fired during this exercise. Submarines also use their high-frequency sonar for object avoidance and navigation safety. Sonar use by submarines has the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

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| EXERCISE TYPE | SINKEX | EER/IEER/MAC | RANGE OPERATIONS (PUTR) | BOMBEX [A-S] | GUNEX [A-S, S–S, S-A] | MISSILEX [A-A, S-A] | ASW Helicopter or MPA | ASW Surface | ASW Submarine |
|---|---|---|---|---|---|---|---|---|---|
| **Sources / Weapons / Rounds** | MK-48<br>MK-82 (Inert/HE)<br>MK-83 (HE)<br>AGM-88 HARM<br>AGM-84 Harpoon<br>AGM-65 Maverick<br>AGM-114 Hellfire<br>AGM-119 Penguin<br>Standard Missile 1<br>Standard Missile 2<br>5"/54 BLP (Inert) | SSQ-110A<br>(5 lb NEW)<br>SSQ-125 | MK-84 pingers | MK 82/83/84<br>BDU-45 | 5" (Inert/HE)<br>76mm (Inert/HE<br>57mm (Inert)<br>25mm (Inert)<br>20mm (Inert)<br>7.62mm (inert)<br>.50 cal (inert) | Standard missle<br>Sea Sparrow<br>RAM<br>AIM-7/9/120 | AN/SSQ-62 DICASS<br>AN/ASQ-22 | AN/SQS-53 MFA Sonar<br>AN/SQS-56 MFA Sonar<br>MK-39 EMATT | BQQ-10 Submarine Sonar<br>BQS-15 Submarine sonar<br>SUS MK-84 Sonobuoy |
| **Explosion in or on water** | Yes | Yes - SSQ-110A<br>No - SSQ-125 | No | Yes | Yes | No | No | No | No |
| **Length of Exercise** | 4-8 hrs over 2 days | 6 hrs | 4 hrs | 1 hr | 2-3 hrs | 1 hr | 2-4hrs | 5-7 days | 2-3 days |
| **Detonations / hours/ rounds / sonobuoy or torpedo deployments, or helicopter sonar dips per exercise or year** | MK-82 (Inert) = 3<br>MK-82 (HE) = 7<br>MK-83 (HE) = 4<br>AGM-88 HARM = 2<br>AGM-84 Harpoon = 5<br>AGM-65 Maverick = 3<br>AGM-114 Hellfire = 1<br>AGM-119 Penguin = 1<br>Standard Missile 1 = 1<br>Standard Missile 2 = 1<br>5"/54 BLP = 500 rounds | 80 deploy/yr | MK-84 pingers = 80hrs | MK-82 (HE) = 128<br>MK-83 (HE) = 12<br>MK-84 = 4 (1 HE)<br>BDU-45 (inert) = 216 | 5" (Inert) = 48<br>5" (HE) = 84<br>76mm (Inert) = 16<br>76mm (HE) = 28<br>57mm (Inert) = 200<br>25mm (Inert) = 6,000<br>20mm (Inert) = 20,000<br>7.62mm (inert) = 9,000<br>.50 cal (inert) = 2,400 | **S-A**<br>Standard missle, Sea Sparrow, RAM = 6<br>**A-A**<br>AIM-7 = 18<br>AIM-9 = 24<br>AIM-120 = 18 | AN/SSQ-62 DICASS<br>AN/ASQ-22 = 192 | AN/SQS-53 = 578hrs<br>AN/SQS-56 = 52<br>MK-39 EMATT = 12hrs | BQQ-10 = 48hrs<br>BQS-15 =24hrs<br>SUS MK-84 = 24 |
| **Number Exercises per Year** | 2 | 4 | 20 | 36 | 32 | 6 | 44 | 3 | 3 |
| **Area Used** | TMAA | TMAA | TMAA | TMAA | TMAA | TMAA | TMAA | TMAA | TMAA |
| **Months of Yr** | April - October | April - October | April - October | April - October | April - October | April - October | April - October | April - October | April - October |

**Table 2.** Summary of Navy training activities in GoA TMAA and associated componets.

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**Activities Utilizing Underwater Detonations**

Underwater detonation activities can occur at various depths. They may include activities with detonations at or just below the surface (such as SINKEX or gunnery exercises (GUNEX)). When the weapons hit the target, 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 to explode 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 2. Additionally, successful hit rates are known to the Navy and are utilized in the effects modeling. Training events that involve explosives and underwater detonations are described below and summarized in Table 3.

TABLE 3—SOURCES OF AT-SEA EXPLOSIVES USED IN GOA TMAA FOR WHICH TAKE OF MARINE MAMMALS IS ANTICIPATED

| Ordnance/explosive | Net explosive weight (in lbs.) | Sub-TTS | TTS | Injury | Mortality | Exclusion zone Used (m) |
|---|---|---|---|---|---|---|
| | | 177dB | 182 SEL/23psi | 50% TM rupture, 205db or 23 psi-ms | Onset massive lung injury or 31 psi-ms | |
| 5″ Naval gunfire | 9.54 | 413 | 227/269 | 43 | 23 | 549 |
| 76 mm Rounds | 1.6 | 168 | 95/150 | 19 | 13 | 549 |
| MK–82 | 238 | 2720 | 1584/809 | 302 | 153 | 914 |
| MK–83 | 574 | 4056 | 2374/1102 | 468 | 195 | 914 |
| MK–84 | 945 | 5196 | 3050/1327 | 611 | 226 | 914 |
| SSQ–110 IEER | 5 | NA | 325/271 | 155 | 76 | 914 |
| MK–48 | 851 | NA | 2588/1198 | 762 | 442 | 1852 |

Table Also Indicates Range to Indicated Threshold and Size of Navy Exclusion Zone Used in Mitigation. Units Are Meters.

*Sinking Exercise* (SINKEX)—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 hulks. 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. The Navy proposes to conduct one SINKEX during each summertime exercise in the GoA TMAA (maximum of two). Potential harassment would be from underwater detonation. SINKEX events have been conducted in the Pacific at Navy training range complexes off Southern California, the Pacific Northwest, Hawaii, and the Mariana Islands, 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 1–7 in the Navy's application indicates the typical ordnance that may be used in a SINKEX, which may include missiles, bombs, 5" gunfire, and a single MK–48 torpedo. This table reflects the planning for weapons, which may be expended during one SINKEX in the GoA TMAA. This level of ordnance is expected for each of the two possible SINKEX events in the GoA TMAA. With the exception of the single 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)*—These exercises train surface ship crews in high-speed surface engagement procedures against mobile (towed or self-propelled) seaborne targets. Both live and inert training rounds are used against the targets. The training consists of the pre-attack phase, including locating, identifying, and tracking the threat vessel, and the attack phase in which the missile is launched and flies to the target. In a live-fire event, aircraft conduct a surveillance flight to ensure that the range is clear of nonparticipating ships. These activities may occur within the GoA TMAA and have the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

For S–S GUNEX from a Navy ship, gun crews engage surface targets at sea with their main battery 5-inch and 76mm guns as well as smaller surface targets with 25mm, 0.50-caliber (cal), or 7.62mm machine guns, with the goal of disabling or destroying the threat target. For a surface-to-surface GUNEX from a Navy small boat, the weapon used is typically a 0.50 cal, 7.62-mm, or 40-mm machine gun.

The number of rounds fired depends on the weapon used for S–S GUNEX. For 0.50-cal, 7.62-mm, or 40-mm ordnance, the number of rounds is approximately 200, 800, and 10 rounds, respectively. For the ship main battery guns, the gun crews typically fire approximately 60 rounds of 5-inch or 76-mm ordnance during one exercise. These activities may occur within the GoA TMAA.

*Air-to-Surface Gunnery Exercise (A–S GUNEX)*—Strike fighter aircraft and helicopter crews, including embarked

Naval Special Warfare (NSW) personnel use guns to attack surface maritime targets, day or night, with the goal of destroying or disabling enemy ships, boats, or floating or near-surface mines. These training activities have the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

For fixed-wing A–S GUNEX, a flight of two F/A–18 aircraft will begin a descent to the target from an altitude of about 3,000 ft (914 m) while still several miles away. Within a distance of 4,000 ft (1,219 m) from the target, each aircraft will fire a burst of about 30 rounds before reaching an altitude of 1,000 ft (305 m), then break off and reposition for another strafing run until each aircraft expends its exercise ordnance allowance of about 250 rounds from its 20mm cannon.

For rotary-wing A–S GUNEX, a single helicopter will carry several air crewmen needing gunnery training and fly at an altitude between 50 and 100 ft (15 to 30 m) in a 300-ft (91-m) racetrack pattern around an at-sea target. Each gunner will expend about 200 rounds of 0.50 cal and 800 rounds of 7.62-mm ordnance in each exercise. The target is normally a noninstrumented floating object such as an expendable smoke float, steel drum, or cardboard box, but may be a remote-controlled speed boat or jet ski type target. The exercise lasts about 1 hour and occurs within the GoA TMAA.

*Air-to-Surface Missile Exercise (A–S MISSILEX)*—An air-to-surface MISSILEX involves fixed-winged aircraft and helicopter crews launching missiles at surface maritime targets, day and night, with the goal of training to destroy or disable enemy ships or boats. These activities may occur within the TMAA; however, all missile launches would be simulated; therefore, MISSILEX activities are not likely to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities.

For helicopter A–S MISSILEX, one or two MH–60R/S helicopters approach and acquire an at-sea surface target, which is then designated with a laser to guide an AGM–114 Hellfire missile to the target. The laser designator may be onboard the helicopter firing the hellfire, another helicopter, or another source. The helicopter simulates launching a missile from an altitude of about 300 ft (91 m) against a specially prepared target with an expendable target area on a nonexpendable platform. The platform fitted with the expendable target could be a stationary barge, a remote-controlled speed boat, or a jet ski towing a trimaran whose infrared signature has been augmented with a heat source (charcoal or propane) to better represent a typical threat vessel. All missile firings would be simulated.

For an air-to-surface MISSILEX fired from fixed-wing aircraft, the simulated missile used is typically an AGM–84 Standoff Land Attack Missile-Expanded Response (SLAM–ER), an AGM–84 Harpoon, or an AGM–65 Maverick. A flight of one or two aircraft approach an at-sea surface target from an altitude between 40,000 ft (12,192 m) and 25,000 ft (7,620 m) for SLAM–ER or Harpoon, and between 25,000 ft (7,620 m) and 5,000 ft (1,524 m) for Maverick, complete the internal targeting process, and simulate launching the weapon at the target from beyond 150 nm (278 km) for SLAM–ER and from beyond 12 nm (22 km) for Maverick. The majority of unit level exercises involve the use of captive carry (inert, no release) training missiles; the aircraft perform all detection, tracking, and targeting requirements without actually releasing a missile. These activities may occur within the GoA TMAA and all missile launches would be simulated.

*Air-to-Surface Bombing Exercise (BOMBEX)*—During an air-to-surface BOMBEX, maritime patrol aircraft (MPA) or F/A–18 deliver free-fall bombs against surface maritime targets, with the goal of destroying or disabling enemy ships or boats.

A flight of one or two aircraft will approach the target from an altitude of 15,000 ft (4,570 m) to less than 3,000 ft (914 m) while adhering to designated ingress and egress routes. Typical bomb release altitude is below 3,000 ft (914 m) and within a range of 1,000 yards (yd) (914 m) for unguided munitions, and above 15,000 ft (4,572 m) and in excess of 10 nm (18 km) for precision-guided munitions. Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from aircraft releasing ordnance or a support aircraft are used to illuminate certified targets for use with lasers when using laser guided weapons. Bombs used could include BDU–45 (inert) or MK–82/83/84 (live and inert). These activities may occur within the GoA TMAA and have the potential to disturb a marine mammal or marine mammal stock resulting in MMPA Level B harassment as defined for military readiness activities. In the near future, the Navy will be transitioning all carrier based MK–80 series bombs to BLU 110, 111, and 117 live and inert bombs. The difference is that the BLU-series bombs contain insensitive (less likely to accidently explode) high explosives, which make them safer for carrier-based operations. All other attributes would remain the same.

*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 has two components: An AN/SSQ–110A Sonobuoy, which generates a sound similar to a "sonar ping" using a small explosive; and a passive AN/SSQ–77 Sonobuoy, which "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 MAC system (described in the sonar source section) will eventually replace the EER/IEER system and was analyzed for this proposed rule.

**Vessel Movement**

Many of the proposed activities within the GoA TMAA involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). According to the Navy's application, up to seven Navy vessels (six surface ships and one submarine) may be operating within the GoA TMAA. In addition, the Navy's DEIS stated that under the preferred alternative (Alternative 2) 19 contracted support vessels may also be operating within the GoA TMAA. Within the maximum two summer exercises, the length of the exercise, the number of vessels, and the allotted at-sea time within the GoA TMAA during an exercise will be variable between years. These variations cannot be predicted given unknowns including the availability of participants for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (*e.g.,* tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GoA.

Vessel movements have the potential to affect marine mammals by directly striking or disturbing individual animals. The probability of vessel and marine mammal interactions occurring in the GoA TMAA is dependent on several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. During training activities, speeds vary and depend on the specific training activity. In general, Navy vessels move in a coordinated manner, but can be separated by many miles in distance. These activities are widely dispersed throughout the GoA TMAA, which is a vast area encompassing 42,146 $nm^2$ (145,458 $km^2$). Consequently, the density of Navy vessels within the GoA TMAA at any given time is extremely low.

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

**Description of Marine Mammals in the Area of the Specified Activities**

Twenty-six marine mammal species or populations/stocks have confirmed or possible occurrence within or adjacent to the GoA, including seven species of baleen whales (mysticetes), 13 species of toothed whales (odontocetes), five species of seals (pinnipeds), and the sea otter (mustelid). Nine of these species are ESA-listed and considered depleted under the MMPA: Blue whale, fin whale, humpback whale, sei whale, sperm whale, North Pacific right whale, Cook Inlet beluga whale, Steller sea lion, and sea otter. Table 4 summarizes their abundance, Endangered Species Act (ESA) status, occurrence, density, and likely occurrence in the TMAA during the April to October timeframe. The sea otter 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 | ESA/ MMPA Status | Occurrence Apr-Dec | Abundance | Density* /km^2 |
|---|---|---|---|---|---|
| **Mysticetes** | | | | | |
| Blue whale | *Balaenoptera musculus* | E, D, S | Rare | 1,368 | NA |
| Fin whale | *Balaenoptera physalus* | E, D, S | Common | 2,636 | 0.01 |
| Sei whale | *Balaenoptera borealis* | E, D, S | Rare | 43 | NA |
| Minke whale | *Balaenoptera acutorostrata* | | Rare | Unknown | 0.0006 |
| Humpback whale | *Megaptera novaeangliae* | E, D, S | Common | 4,005 | 0.0019 |
| Gray whale | *Eschrichtius robustus* | | Common | 18,813 | 0.0125 |
| North Pacific right whale | *Eubalaena japonica* | E, D, S | Rare | Unknown (<100) | NA |
| **Odontocetes** | | | | | |
| Sperm whale | *Physeter macrocephalus* | E, D, S | Rare | Unknown | 0.0003 |
| Baird's beaked whale | *Berardius bairdii* | | Rare | Unknown | 0.0005 |
| Cook Inlet beluga whale | *Delphinaptera leucas* | E, D, S | Extra-limital | 375 | NA |
| Cuvier's beaked whale | *Ziphius cavirostris* | | Common | Unknown | 0.0022 |
| Dall's porpoise | *Phocoenoides dalii* | | Common | 83,400 | 0.1892 |
| False killer whale | *Pseudorca crassidens* | | Extra-limital | Unknown | NA |
| Killer whale (multiple stocks) | *Orcinus orca* | | Common | 249-1,123 | 0.01 |
| Pacific white-sided dolphin | *Lagenorhynchus obliguidens* | | Common | 26,880 | 0.0208 |
| Risso's dolphin | *Grampus griseus* | | Extra-limital | 11,621 | NA |
| Short-finned pilot whale | *Globicephala macrorhynchus* | | Extra-limital | 245 | NA |
| Harbor porpoise | *Phocoena phocoena* | | Rare | 41,854 | NA |
| Northern right whale dolphin | *Lissodelphis borealis* | | Extra-limital | 12,876 | NA |
| Stejneger's beaked whale | *Mesoplodon stejnegeri* | | Common | Unknown | .0022** |
| **Pinniped** | | | | | |
| Stellar sea lion (eastern stock) | *Eumetopias jubatus* | T, D, S | Common | 45,095-55,832 | 0.0098 |
| Stellar sea lion (western stock) | *Eumetopias jubatus* | E, D, S | Common | 38,988 | 0.0098 |
| California sea lion | *Zalophus californianus* | | Rare | 238,000 | NA |
| Harbor seal | *Phoca vitulina richardii* | | Rare | 45,975 | NA |
| Northern elephant seal | *Mirounga angustirostris* | | Common | 124,000 | 0.0022 |
| Northern fur seal | *Callorhinus ursinus* | D, S | Common | 665,500 | 0.118 |
| **Mustelid** | | | | | |
| Sea otter | *Enhydra lutris* | T, S | Extra-limital | Unknown | NA |

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

* Density derived for summer (appendix B)

** Cuvier's beaked whale density used as surrogate

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*Species Not Considered Further*

*Cook Inlet Beluga Whale*—The likelihood of a Cook Inlet beluga whale (*Delphinapterus leucas*) occurring in the TMAA is extremely low. Only 28 sightings of beluga whales in the GoA have been reported from 1936 to 2000 (Laidre *et al.,* 2000). The nearest beluga whales to the TMAA are in Cook Inlet with a 2008 abundance estimate of 375 whales in the Cook Inlet stock (NMFS 2008). In October 2008, the Cook Inlet beluga whale distinct population segment was listed as endangered under the ESA (73 FR 62919, October 22, 2008). Prior to listing, the population had been designated as depleted under the MMPA (NMFS, 2008). Cook Inlet is approximately 70 nm (129.6 km) from the nearest edge of the TMAA and the Cook Inlet beluga whales do not leave the waters of Cook Inlet (NMFS, 2007, 2008). Based on this information, it is highly unlikely for a Cook Inlet beluga whale to be present in the action area. Consequently, this distinct population segment will not be considered in the remainder of this analysis.

*False Killer Whale*—The likelihood of a false killer whale (*Pseudorca crassidens*) being present in the TMAA is extremely low. False killer whales are found in tropical and temperate waters, generally between 50° S and 50° N latitude (Baird *et al.,* 1989; Odell and McClune, 1999). The southernmost point boundary of the TMAA is well north of 55° N latitude. There have been records of false killer whale sightings as far north as the Aleutian Islands and Prince William Sound in the past (Leatherwood *et al.,* 1988). In addition, a false killer whale was sighted in May 2003 near Juneau, but this was considered to be far north of its normal range (DoN, 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, false killer whales are considered extralimital to the TMAA and will not be considered further in this analysis.

*Northern Right Whale Dolphin*—The likelihood of a northern right whale dolphin (*Lissodelphis borealis*) occurring in the TMAA is extremely low. This species occurs in North Pacific oceanic waters and along the outer continental shelf and slope in cool temperate waters colder than 20° C. This species is distributed approximately from 30° N to 55° N and 145° W to 118° E (both south and east of the TMAA). There are two records of northern right whale dolphins in the GoA (one just south of Kodiak Island), but these are considered extremely rare (DoN, 2006). There are no abundance estimates for this species in the NMFS stock assessment report for this area of the Pacific. Given the extremely low likelihood of this species occurrence in the action area, the northern right whale dolphin will not be considered further in this analysis.

*Risso's Dolphin*—The likelihood of Risso's dolphin (*Grampus griseus*) occurring in the action area is extremely low. The Risso's dolphin is distributed worldwide in tropical to warm-temperate waters, roughly between 60° N and 60° S, where surface water temperature is usually greater than 10° C (Kruse *et al.,* 1999). The average sea surface temperature for the GoA is reported to be approximately 9.6° C and has undergone a warming trend since 1957 (Aquarone and Adams, 2008). The average summer temperature within the upper 328 ft (100 m) of the TMAA is approximately 11° C based on data as presented in the modeling analysis undertaken by the Navy. In the eastern Pacific, Risso's dolphins range from the GoA to Chile (Leatherwood *et al.,* 1980; Reimchen, 1980; Braham, 1983; Olavarria *et al.,* 2001). Water temperature appears to be a factor that affects the distribution of Risso's dolphins in the Pacific (Leatherwood *et al.,* 1980; Kruse *et al.,* 1999). Risso's dolphins are expected to be extralimital in the TMAA. They prefer tropical to warm temperate waters and have seldom been sighted in the cold waters of the GoA. Records of Risso's dolphins near the TMAA include sightings near Chirikof Island (southwest of Kodiak Island) and offshore in the GoA, just south of the TMAA boundary (Consiglieri *et al.,* 1980; Braham, 1983). Given the extremely low likelihood of this species occurrence in the action area, the Risso's dolphin will not be considered further in this analysis.

*Short-Finned Pilot Whale*—Short-finned pilot whales (*Globicephala macrohynchus*) are not expected to occur in the GoA TMAA. This species is found in tropical to warm temperate seas, generally in deep offshore areas, and they do not usually range north of 50° N (DoN, 2006). There are two records of this species in Alaskan waters. In 1937, a short-finned pilot whale was taken near Katanak on the Alaska Peninsula and a group of five short-finned pilot whales were sighted just southeast of Kodiak Island in May 1977 (DoN, 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. Given the extremely low likelihood of this species' occurrence in the action area, the short-finned pilot whale will not be considered further in this analysis.

The Navy has compiled information on the abundance, behavior, status and distribution, and vocalizations of marine mammal species in the GoA TMAA 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 designated stocks of marine mammals in the waters surrounding the GoA TMAA and, therefore, compiles stock assessment reports for this area. This information may be viewed in the Navy's LOA application and/or the Navy's DEIS for the GoA TMAA (see Availability), and is incorporated by reference herein.

There are no designated marine mammal critical habitats or known foraging areas within the GoA TMAA; however, critical habitats for two ESA-listed species have been designated in the vicinity of the GoA TMAA. On April 8, 2008, NMFS designated two areas as North Pacific right whale critical habitat—one in the GoA and one in the Bering Sea (73 FR 19000). The GoA critical habitat is located approximately 16 nm (30 km) west of the southwest corner of the TMAA. NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). For the western Distinct Population Segment (DPS), "aquatic zone" critical habitat surrounding haulouts and rookeries extends 20 nm (37 km) seaward in state and federally managed waters, portions of which are adjacent to the TMAA.

Much is unknown about the feeding habits of the dolphin and porpoise species in the GoA TMAA, but they are thought to feed opportunistically throughout their range (like better studied species and stocks are known to do) and possibly throughout the year. Even less is known about the feeding habits of beaked whales. Baleen whales and sperm whales are thought to forage seasonally in areas within and around the GoA TMAA. For example, Moore *et al.* (2007) provided evidence of a year-round occurrence of gray whales and a noteworthy feeding area in the northeastern GoA (southeast of Kodiak Island).

*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 underwater. 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 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 whale social vocalizations is concentrated near 10 kHz, with source levels for whistles as high as 100 to 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 5a and Table 5b list the species found in the GoA TMAA and include a summary of their vocalizations, if available. 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 | |
| **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 | | | |
| **North Pacific right whale** | call | <0.400 | <0.200 | | |
| | moans | <0.400 | | | |
| **Gray whale** | call | 0.2 - 2.5 | 1 - 1.5 | | |
| | moans | 0.02 - 1.20 | 0.020 - 0.200, 0.700 - 1.2 | 185 | |
| | modulated pulse | 0.08 - 1.8 | 0.225 - 0.600 | | |
| | FM sweeps | 0.10 - 0.35 | 0.3 | | |
| | pulses | 0.10 - 2 | 0.300 - 0.825 | | |
| *Calf* | clicks | 0.10 - 20 | 3.4 - 4 | | |

**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 | Source Level (dB | Duration / Other |
|---|---|---|---|---|---|
| **Sperm whale** | clicks | 0.1 - 30 | 2 - 4, 10 - 16 | 160 - 180 | < 30 ms |
| | short clicks | | | 236 | < 1 μs, highly |
| | trumpets | | | 172 | |
| *Neonate* | clicks | | 0.5 | 140 - 162 | < 2 to 12 ms, low |
| **Baird's beaked whale** | echolocation | .3 - 129 | | | |
| | social | 0.002 - 0.016 | | | |
| **Cuvier's beaked whale** | echolocation clicks | 20 - 40, 20 - 70 | | 214 | < 200 to 250 μs, |
| | whistles | 8 - 12 | | | upsweep lasts 1 s |
| | pulses | 13 - 17 | | | 15 to 44 s |
| **Stejneger's beaked whale** | | | | | |
| **Dall's porpoise** | clicks | | 120 - 160 | | 50 to 1,500 μsec |
| | clicks | 0.04 - 12 / - | - / 135 - 149 | ) - 148 / 165-175 | |
| **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 | |
| **Pacific white-sided dolphin** | whistles | .002 - .02 | 12-Apr | | |
| | pulse trains for | - / - | 50 - 80 / 60 -80 | 170 / 180 | |
| **Harbor porpoise** | clicks | 2 | | 100 | |
| | pulse | 100 - 160 | 110 - 150 | | |
| | click | | 110 - 150 | 135 - 177 | |
| **Northern right whale dolphin** | whistles, tones | 1 - 16 | 1.8, 3 | | |
| **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 |
| **Short-finned pilot whale** | whistles | 0.5 - > 20 | 2 to 14 | 180 | |
| | click | | 30 - 60 | 180 | |
| **Northern elephant seal** | | | | | |
| **Pacific harbor seal** | communication | .100 - 1 | | | |
| | clicks | 8 - 150 | 12 - 40 | | |
| | roar | 0.4 - 4 | 0.4 - 0.8 | | |
| | growl, grunt, groan | < 0.1 - 0.4 | < 0.1 - 0.25 | | |
| | creak | 0.7 - 4 | 0.7 - 2 | | |
| **California sea lion** | barks | < 8 | < 3.5 | | |
| | whinny | < 1 - 3 | | | |
| | clicks | | 0.5 - 4 | | |
| | buzzing | < 1 - 4 | < 1 | | |
| **Harbor seal** | clicks | 8 - 150 | 12 - 40 | | |
| | roar | 0.4 - 4 | 0.4 - 0.8 | | |
| | growl, grunt, groan | <0.1 - 0.4 | <0.1 - 0.25 | | |
| | creak | 0.7 - 4 | 0.7 - 2 | | |
| **Northern fur seal** | clicks, bleats | | | | |
| **Steller sea lion** | clicks, growls | | | | |

**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. Furthermore, 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).

Density is nearly always reported for an area (*e.g.,* animals per $km^2$). Analyses of survey results using distance sampling techniques include correction factors for animals at the surface but not seen as well as animals below the surface and not seen. Therefore, although the area (*e.g.,* $km^2$) appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. In addition, density assumes that animals are uniformly distributed within the prescribed area, even though this is likely a rare occurrence. Marine mammals are usually concentrated in areas of greater importance, such as areas of high productivity, low predation, safe calving, etc. Density can occasionally be calculated for smaller areas that are regularly used by marine mammals, but more often than not, there are insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

Recent survey data for marine mammals in the GoA is limited and most survey efforts were localized and extremely nearshore. In addition to the visual surveys, there is evidence of several species based on acoustic studies, but these do not provide measurements of abundance (*e.g.,* Stafford, 2009).

In April 2009, the Navy funded and NMFS conducted the Gulf of Alaska Line-Transect Survey (GOALS) to address the data needs for this analysis (Rone *et al.,* 2009). Line-transect survey visual data to support distance sampling statistics and acoustic data were collected over a 10-day period both within and outside the TMAA. This survey resulted in sightings of several species and allowed for the derivation of densities for fin and humpback whale (Rone *et al.,* 2009). In addition to this latest survey, two previous vessel surveys conducted in the nearshore region of the TMAA were also used to derive the majority of the density data used in acoustic modeling for this analysis. The methods used to derive density estimates for all remaining species in the TMAA are detailed in Appendix B of the LOA application and summarized below.

Zerbini *et al.* (2006) conducted dedicated vessel surveys for large whales in summer 2001–2003 from Resurrection Bay on the Kenai Peninsula to Amchitka Island in the Aleutian Islands. Survey effort near the TMAA was nearshore (within approximately 46 nm (85 km) of shore), and is delineated as "Block 1" in the original paper. Densities for this region were published for fin and humpback whales.

Waite (2003) conducted vessel surveys for cetaceans near Kenai Peninsula, within Prince William Sound and around Kodiak Island, during acoustic-trawl surveys for pollock in summer 2003. Surveys extended offshore to the 1,000 m isobaths and therefore overlapped with some of the TMAA. Waite (2003) did not calculate densities, but did provide some of the elements necessary for calculating density (please see Appendix B of the LOA application for more information).

Mysticetes occurring in the GoA include blue, fin, gray, humpback, minke, North Pacific right, and sei whales (Angliss and Allen, 2008; Rone *et al.,* 2009). Blue, North Pacific right, and sei whales are considered rare, and are included here only for discussion purposes due to their designations as "depleted" under the MMPA and "endangered" under the ESA.

Gray whale density was calculated from data obtained during nearshore feeding studies in the GoA. Gray whales are found almost exclusively in near shore areas; therefore, they would not be expected to be found in the majority of the TMAA (≤50 nm (93 km) offshore and >5,997 ft (1,828 m) depth) (DoN, 2006). The recent 2009 survey encountered one group of two gray whales on the shelf within the western edge of the TMAA and two groups well outside the TMAA near shore at Kodiak Island (Rone *et al.,* 2009).

Odontocetes occurring regularly include sperm whale, Cuvier's, Baird's, and Stejneger's beaked whales, killer whale, Pacific white-sided dolphin, and Dall's porpoise (Angliss and Allen, 2008; Rone *et al.,* 2009). In Alaska waters, harbor porpoise inhabit coastal waters where depths are less than 328 ft (100 m) in depth (DoN, 2006; Angliss and Allen, 2008). The majority of the TMAA is well offshore of the normal habitat range for harbor porpoise. There is no density data available for this species in the nearshore portion of the TMAA that overlaps the harbor porpoise range. An estimated quantification of impacts for harbor porpoise was, however, undertaken as described in the Potential Effects of Specified Activities on Marine Mammals section.

Pinnipeds occurring regularly include Steller sea lion, northern fur seal, and northern elephant seal. The range of California sea lions extends as far north as the Pribolof Islands in the Bering Sea. Tagging data indicate that most northern fur seal foraging and migration takes place to the west of the TMAA (Ream *et al.,* 2005), although the derived density for this species assumed the population would be present in the area for modeling purposes. Harbor seals are primarily a coastal species and are rarely found more than 12 mi (20 km) from shore (DoN, 2006). Harbor seals should be very rare in the TMAA and there was no attempt to model for this species.

Pinniped at-sea density is not often available because pinniped abundance is obtained via shore counts of animals at known rookeries and haulouts. Lacking any other available means of quantification, densities of pinnipeds were derived using shore counts. Several parameters were identified for pinnipeds from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Once density per "pinniped season" was determined, those values were prorated to fit the warm water (June through October) and cold water (November through May) seasons. Determining density in this manner is risky because the parameters used usually contain error (*e.g.,* geographic range is not exactly known and needs to be estimated and abundance estimates usually have large variances). As is true of all density estimates, they assume that the animals are always distributed evenly within an area which is likely never true.

**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, but rather 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 10 dB). 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. Because of the different densities of air and water and the different decibel standards (*i.e.,* reference pressures) in air and water, 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 measures 160 dB underwater would have the same approximate effective intensity as a sound that is 97 dB 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 3 km 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 activities in the GoA TMAA 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 GoA TMAA DEIS, including ship strike, aerial overflights, ship noise and movement, and others, and, in consultation with NMFS as a cooperating agency for the GoA TMAA DEIS, has determined that take of marine mammals incidental to these non-acoustic components of the GoA TMAA 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 GoA TMAA.

For the purpose of MMPA authorizations, NMFS' effects assessments serve four primary purposes: (1) To help identify the permissible methods of taking, or 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.

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 11 of NMFS' June 28, 2010, biological opinion for the Mariana Islands Range Complex (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 (*e.g.,* 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 TS: 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 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 (*e.g.,* 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) speculates 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, the detection of frequencies above those of the masking stimulus decreases. 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 that low-frequency sounds 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 higher 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 with the frequencies of the MFAS/HFAS sources used in the Navy's MFAS/HFAS training exercises (although some mysticetes' 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 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 adjustments to vocalization characteristics such as the frequency structure, amplitude, temporal structure and 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 to 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 responses.

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), 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 impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and 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 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 anthropogenic sound exposure, 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 and mid-frequency sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (*e.g.,* 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 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 the 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 subsections 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 the speed of approach, all 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 of western gray 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 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 local seismic activities. 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 foraging ground and the whales left the area and moved farther south to the Sea of Okhotsk. They only returned to the foraging ground 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 are 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. Avoidance 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. However, longer term displacement is possible and can lead to changes in abundance or distribution patterns of the species in the affected region if animals 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 long-term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to result from 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*) 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 the following behaviors: immediately swimming away (horizontally) from the source of the sound; engaging in a series of erratic and frequently deep dives that seemed to take it below the sound field; or 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 a 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, 2008a).

The preliminary BRS–08 cruise report has been published. Although the extensive data sets emerging from this study will require detailed analysis, researchers have identified an emerging pattern of responses. For example, Blainville's beaked whales—a resident species within the study area—appear to be sensitive to noise at levels well below expected TTS (~160 dB re1μPa). This sensitivity is manifest by an adaptive movement away from a sound source. This response was observed irrespective of whether the signal transmitted was within the band width of MFAS, which suggests that beaked whales may not respond to the specific sound signatures. Instead, they may be sensitive to any pulsed sound from a point source in this frequency range. The response to such stimuli appears to involve maximizing the distance from the sound source (NMFS, 2008b).

*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 more directly approached groups of these animals (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 occur with different behaviors. Variations in respiration rate as a function of acoustic exposure can 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 foraging 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, exposing 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 of 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 respond to 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 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 broad-band 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) 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.

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 suggest that exposures to non-pulse sounds between 90 and 140 dB generally do not result in strong behavioral responses of 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 an effort to develop acoustic criteria.

BILLING CODE 3510–22–P

| | 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.

**BILLING CODE 3510–22–C**

*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 few 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 of animals shifting from one behavioral state (*e.g.,* resting or foraging) to another behavioral state (*e.g.,* avoidance or escape behavior) because of human disturbance or disturbance stimuli.

One consequence of behavioral avoidance results from the changes in 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 speeds that minimize the 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). When vessels approached, the amount of time cows and calves spent resting and milling declined significantly, respectively. 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 percent of the time when vessels were within 300 m compared with 83 percent 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 (*e.g.,* 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 treating the stimulus as a disturbance and responding 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 attend to 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 (*e.g.,* multiple surface vessels), or when they co-occur with times that an animal perceives increased risk (*e.g.,* 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 physical condition of individuals that have been disturbed, followed by reduced reproductive success, reduced survival, or both (Daan *et al.,* 1996; Madsen, 1994; White, 1983). For example, Madsen (1994) reported that pink-footed geese (*Anser brachyrhynchus*) in undisturbed habitat gained body mass and had about a 46 percent reproductive success 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 percent 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), and caribou disturbed by low-elevation military jet flights (Luick *et al.,* 1996; 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 ($50.2 \times 10^3$ 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; NMFS, 2007). The legal definition for a stranding within the United States is that "(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 U.S.C. 1421h).

Marine mammals are known to strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most 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 whale (*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 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 2008 Rim of the Pacific (RIMPAC) exercises, between 150 and 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-km 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 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 and March 16, 2000. The ships, which operated both AN/SQS–53 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 ten 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 to May 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 and 80 warships, took place in Portugal between May 2 and May 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 (1,000 m) depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 (1,000 to 6,000 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 (1,000 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 the 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 alive on the evening of January 26. 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. Between January 25 and 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 (1,000 m) depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 fathoms (1,000 to 6,000 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 hrs) in close proximity; and 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 and 4, 2004, approximately 150 to 200 melon-headed whales occupied the shallow waters of the Hanalei Bay, Kaua'i, Hawaii for over 28 hrs. 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. Cause of death could not be definitively determined, but 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 animals' movement into the Bay and subsequent 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, 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 the following: (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 to 700 melon-headed whales came into Sasanhaya Bay on July 4, 2004 near the island of Rota and then left of their own accord after 5.5 hrs; 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 no 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 percent of the total number of stranded animals), other beaked whales (including *Mesoplodon europeaus, M. densirostris,* and *Hyperoodon ampullatus*) comprise 14 percent of the total. Other species, 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 make 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 mammal 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 (*e.g.,* acoustically mediated bubble growth, as 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 the following: 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 (*e.g.,* 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. Furthermore, beaked whales exposed to active sonar might alter their dive behavior. Changes in dive behavior might cause them to remain at the surface or at depth for extended periods of time which could lead to hypoxia by increasing their oxygen demands or increasing their energy expenditures (*i.e.,* the energy needed to remain at depth, which would increase their oxygen demand). 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 (*e.g.,* 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 (up to 2 kilometers) and long (up to 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 (*e.g.,* causing beaked whales to spend more time at surface without the bounce dives that are necessary for recovery) 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 three 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 GoA TMAA, NMFS recommends caution when either steep bathymetry, surface ducting conditions, 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.

*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 depend 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, and 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 densities. 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 (see Noise-induced Threshold Shift Section above; Ketten, 1995). 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 a 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 mammal taxonomy groups, Richardson *et al.* (1995) provides 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 interest (*e.g.,* approaching vessels) to generally uninterested reactions; finback whales (*B. physalus*) changed from mostly negative (*e.g.,* 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 reactions that were often strongly positive. 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 (*e.g.,* 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 (*e.g.,* 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 percent) resulted in serious injury or death (19 of those 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 resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79 percent) 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 percent to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent 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 goes 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 percent).

The probability of vessel and marine mammal interactions occurring in the GoA TMAA 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 that may be operating in the GoA TMAA varies based on training schedules and can typically range from zero to about ten vessels per 21-day exercise cycle. 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 rigid-hulled inflatable boats (RHIBs), may also be utilized in the GoA TMAA. 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 to three weeks. These training events are widely dispersed; consequently, the density of ships within the GoA TMAA at any given time is extremely low (*i.e.,* approximately 0.0002 ships/nm$^2$). Moreover, naval vessels transiting the GoA TMAA 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 GoA TMAA 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; and 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 GoA TMAA, 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 GoA TMAA application are considered military readiness activities.

NMFS reviewed the proposed GoA TMAA activities and the proposed GoA TMAA 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 GoA, and the Navy and NMFS subsequently coordinated and produced the draft Stranding Response Plan for the GoA, 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—Watchstanders and Lookouts

The use of shipboard lookouts is a critical component of all Navy mitigation measures. Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their 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, OODs, Junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW) helicopter crews would complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). MSAT may also be viewed on-line at *https://portal.navfac.navy.mil/go/msat.* MSAT training must be reviewed at least annually and again prior to the first use of mid-frequency active sonar (MFAS) and/or IEER during major ASW exercises. 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, and must be recorded in the individual's training record.

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).

Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. 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 lookouts required by a particular mitigation measure as long as supervisors monitor their progress and performance.

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.

Operating Procedures and Collision Avoidance (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 would 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 shall watch for and report to the OOD the presence of marine mammals.

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

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.

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 shall 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 Lookout Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968–D).

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 OOD, 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. Navy environmental compliance relies heavily on the abilities of lookouts to detect and avoid protected species. Therefore, it is critical that lookouts be vigilant in their reporting.

While in transit, naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel could take proper and effective action to avoid a collision with any marine animal and could be stopped within a short distance appropriate to the prevailing circumstances and conditions.

When marine mammals 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).

Navy vessels will maneuver to keep at least 1,500 ft (500 yd or 457 m) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course would create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged activities, launching and recovering aircraft or landing craft, minesweeping activities, replenishment while underway, and towing activities that severely restrict a vessel's ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale. Given rapid swimming speeds and maneuverability of many dolphin species, naval vessels shall maintain normal course and speed on sighting dolphins unless some condition indicated a need for the vessel to maneuver.

Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections would be immediately reported to the 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 would likely result in a closing of the distance to the detected marine mammal.

Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of marine mammals. Therefore, where these circumstances are present, the Navy will exercise increased vigilance in watching for marine mammals.

All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records are kept and archived following completion of a major training exercise.

*Operating Procedures (for Mid-Frequency Active Sonar Activities)*

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 yd (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 yd (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yd (183 m) after pinging has begun.

Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1,000 yd (914 m) of the sonar dome (the bow) (*i.e.,* limit to at most 229 dB for AN/SQS–53 and 219 dB for AN/SQS–56, etc.). Ships and submarines shall continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1,000-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1829 m) beyond the location of the last detection.

When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 10 dB below normal operating levels if any detected marine mammals are within 500 yd (457 m) of the sonar dome (the bow). 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 safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 m) beyond the location of the last detection.

When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission ceases if any detected marine mammals are within 200 yd (183 m) of the sonar dome (the bow). Sonar shall not resume until the animal has been seen to leave the 200-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (457 m) beyond the location of the last detection.

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.

Prior to start up or restart of active sonar, operators will check that the 1,000-m safety zone radius around the sound source is clear of marine mammals.

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.

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

If the need for power-down should arise when the Navy is 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).

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

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.

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.

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.

*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.

Vessels will attempt to recover any parachute deploying aerial targets to the extent practicable (and their parachutes if feasible) to reduce the potential for entanglement of marine mammals.

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.

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

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

If surface vessels are involved, the lookouts would visually survey the buffer zone for marine mammals prior to and during the exercise.

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.

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

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

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.

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

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 1,500 ft (457 m). 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 exercises will be conducted only if marine mammals 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 ft (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.

*Sinking Exercises (SINKEX)*

The selection of sites suitable for SINKEX involves a balance of operational suitability and requirements established under the Marine Protection, Research, and Sanctuaries Act (MPRSA) permit granted to the Navy (40 CFR § 229.2). To meet operational suitability criteria, SINKEX locations 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 1,000 fathoms (6,000 ft (1828 m)) deep and at least 50 nm (92.6 km) from land, which may incidentally avoid adverse impacts to marine mammals. In general, most marine mammals 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.

In addition, the Magnuson-Stevens Fisheries Conservation and Management Act (16 U.S.C. 1801 *et seq.*), as amended by the Sustainable Fisheries Act (SFA), mandated identification and conservation of Essential Fish Habitat (EFH) as well as subset of EFH known as Habitat Areas of Particular Concern (HAPC). The guidelines for designating EFH identify HAPCs as types or areas of habitat within EFH that are defined based on one or more of the following considerations: The importance of the ecological function provided by the habitat; the extent to which the habitat is sensitive to human-induced environmental degradation; whether, and to what extent, development activities are or will be stressing the habitat type; and the rarity of the habitat type (50 CFR 600.815(a)(8)). The following HAPCs have been established in the GoA: 10 Gulf of Alaska Slope Habitat Conservation Areas (GOASHCAs), 15 Alaska Seamount Habitat Protection Areas (ASHPAs); and 5 Gulf of Alaska Coral Habitat Protection Areas (NMFS 2006). Within the TMAA, one GOASHCA (Cable) and three ASHPAs (Dall, Giacomini, and Quinn Seamounts) occur almost entirely within the TMAA. Other areas, such as the Kodiak Seamount and Middleton West GOASHCA are partially located in the TMAA. The Navy has agreed not to conduct SINKEXs—the activity with the greatest potential to impact HAPCs—within these areas.

The following mitigation measures shall be applied when conducting a SINKEX in the GoA TMAA:

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

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), shall be surveyed. Together, the zone extends out 2 nm (3.7 km) from the target.

A series of surveillance over-flights shall be conducted within the 2 nm (3.7 km) zone around the target, prior to and during the exercise, when feasible. Survey protocol shall be as follows:

Overflights within the 2 nm (3.7 km) zone around the target 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.

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.

In addition to the overflights, the 2-nm (3.7 km) zone around the target shall be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring will 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.

On each day of the exercise, aerial surveillance of the 2 nm (3.7 km) zone around the target shall commence 2 hours prior to the first firing.

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 this 2 nm (3.7 km) zone around the target is free of marine mammals.

If a marine mammal is observed within the 2 nm (3.7 km) zone around the target, firing will be delayed until the animal is re-sighted outside the 2 nm (3.7 km) zone around the target, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it can be assumed to have left the 2 nm (3.7 km) zone around the target. The OCE will 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 2 nm (3.7 km) zone around the target shall again be surveyed for any marine mammal. If marine mammals are sighted within the 2 nm (3.7 km) zone around the target, the OCE shall be notified, and the procedure described above shall be followed.

Upon sinking of the vessel, a final surveillance of the 2 nm (3.7 km) zone around the target shall be monitored for 2 hours, or until sunset, to verify that no marine mammals were harmed.

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.

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 2 nm (3.7 km) zone around the target. This shall be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

The exercise shall not be conducted unless the 2 nm (3.7 km) zone around the target 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 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 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 shall be submitted to NMFS.

*Explosive Source Sonobuoys (SSQ–110A)*

*AN/SSQ–110A Pattern Deployment*—The following mitigation measures shall be used with the employment of IEER/AEER sonobuoys:

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 500 yd (457 m) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.

For IEER (AN/SSQ–110A), 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 intended sonobuoy pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yd (914 m) of observed marine mammal activity, the Navy shall deploy the receiver only (*i.e.,* not the source) and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yd (914 m) of the intended post position, the source sonobuoy (AN/SSQ–110A/SSQ–125) will be co-located with the receiver.

When operationally feasible, Navy crews shall conduct continuous visual and aural monitoring of marine mammal activity. This shall include monitoring of own-aircraft sensors from the time of the first sensor placement until the aircraft have left the area and are out of RF range of these sensors.

AN/SSQ–110A Pattern Employment

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.

Visual Detection—If marine mammals are visually detected within 1,000 yd (914 m) of the explosive source sonobuoy (AN/SSQ–110A/SSQ–125) intended for use, then that payload shall not be activated. 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 1,000 yd (914 m) safety buffer. Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yd (914 m) safety buffer.

AN/SSQ–110A Scuttling Sonobuoys

For IEER (AN/SSQ–110A), 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 shall ensure that a 1,000 yd (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

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.

The Navy 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.

**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; and 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 would 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 would ensure power-down of MFAS/HFAS by 6 dB when a marine mammal is detected within 1,000 yd (914 m), power-down of 4 more dB (or 10 dB total) when a marine mammal is detected within 500 yd (457 m), and would cease MFAS/HFAS transmissions when a marine mammal is detected within 200 yd (183 m).

*PTS/Injury*—NMFS believes that the proposed mitigation measures would 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 33 ft (10 m); and 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.

*TTS*—NMFS believes that the proposed mitigation measures would 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 584 ft (178 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 would visually detect marine mammals at some point within the 1,000 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 shut down or power-down to avoid exposing these species to sound levels associated with TTS; more cryptic animals that are difficult to detect and observe, such as deep-diving cetaceans (*i.e.,* beaked whales), 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 1-hr subsurface dive by a beaked whale, the ship would have moved over 5 to 10 nm from the original location; and, 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 611 m (688 yd) (large explosives) or 19 m (20.7 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 four animals (three Dall's porpoises and one Northern fur seal) 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: Seventy 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 (*e.g.,* beaked whales) are less likely to be visually detected and could potentially be exposed to explosive levels expected to cause TTS. The model estimated that two beaked whales 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 Fiscal Year 08 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 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

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

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
- 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 Assessment. Furthermore, research cruises by NMFS and by academic institutions have received funding from the U.S. Navy. For example, in April 2009, the U.S. Pacific Fleet contributed approximately $250,000 to support a NMFS marine mammal density survey of the GoA's offshore waters. The goal of this validation monitoring was to increase the state of awareness on marine mammal occurrence, density, and distribution within the GoA. The Navy funded vessel-based line-transect survey conducted from onboard the NOAA ship *Oscar Dyson* determined marine mammal species distribution and abundance in the GoA TMAA. The survey cruise employed multiple observation techniques, including visual and passive acoustic observations, as well as photographic identifications (Rone *et al.,* 2009). In addition to the U.S. Pacific Fleet-funded monitoring initiative, the Chief of Naval Operations Environmental Readiness Division and the Office of Naval Research have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Total Investment in this program between 2004 and 2008 was $100 million. Fiscal Year 09 funding was $22 million and continued funding at levels greater than $14 million is foreseen in subsequent years (beyond 2010).

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.

**Monitoring**

Section 101(a)(5)(A) of the MMPA states that in order to issue an ITA for an activity, 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 increase in 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 GoA TMAA*

The Navy submitted a draft Monitoring Plan for the GoA TMAA 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.

Navy Monitoring Plans are typically designed as a collection of focused "studies" to gather data that will allow the Navy to address one or more of the following questions:

(a) Are marine mammals exposed to MFAS/HFAS (1–10 kHz), 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, 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 and explosives (*e.g.,* Protective Measures Assessment Protocol, major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals?

Given the larger scope of training events within other Navy range complexes as compared to the GoA, not all of these original five study questions would necessarily be addressed within the GoA TMAA Monitoring Plan. Rather, data collected from the GoA monitoring efforts would be used to supplement a consolidated range complex marine mammal monitoring report incorporating data from the Hawaii Range Complex, Marianas Island Range Complex, Northwest Training Range Complex, and Southern California Range Complex.

Data gathered in these studies will be collected by qualified, professional marine mammal biologists that are experts in their field.

Monitoring methods proposed for the GoA include use of passive acoustic monitoring (PAM) to primarily focus on providing additional data or study questions (b) and (c).

This monitoring plan has been designed to gather data on all species of marine mammals that are observed in the GoA TMAA study area; however, the Navy will prioritize monitoring efforts for ESA-listed species and beaked whale species. The Plan recognizes that deep-diving and cryptic species of marine mammals, such as beaked whales and sperm whales, may have low probability of visual detection (Barlow and Gisiner, 2006). Therefore, methods will be utilized to address this issue (*e.g.,* PAM).

During the comment period on the Notice of Receipt (75 FR 5575, February 3, 2010) for the GoA TMAA action, NMFS received multiple public comments suggesting that there are inadequate density, distribution, and abundance data for marine mammals in the GoA TMAA. As mentioned previously, the Navy funded a $250,000 density survey in the off-shore waters of the GoA TMAA in April, 2009. As noted above, the Navy's draft monitoring plan was developed specifically to address distribution and abundance of marine mammals, and the year-round PAM recorders may fill in some of the seasonal data-gaps. NMFS believes that we should vigorously target this baseline information need with the monitoring plan and we will continue to work with the Navy on the draft plan, and in consideration of the public comments that we receive on this proposed rule. During the public comment period, we encourage the public to recommend the most effective regionally specific methods for gathering the needed marine mammal density, distribution, and abundance information and to prioritize the specific data needs (species, time of year, etc.). This information will ensure the design of the most effective Monitoring Plan with the resources available.

In addition to the Monitoring Plan for the GoA, the Navy has established an Integrated Comprehensive Monitoring Program (ICMP). The ICMP is a Navy-wide monitoring framework that will provide an overarching structure and coordination that will, over time, compile data from all Navy range-specific monitoring plans; the GoA TMAA plan is just one component of the ICMP. The overall objective of the

ICMP is to assimilate relevant data collected across Navy range complexes in order to answer questions pertaining to the impact of MFAS and underwater explosive detonations on marine animals. Top priorities of the ICMP include: Monitor Navy training events, particularly those involving MFAS and underwater detonations; collect data to support estimating the number of individuals exposed to sound levels above current regulatory thresholds; assess the efficacy and practicability of monitoring and mitigation tools and techniques and the Navy's current mitigation methods; and add to the overall knowledge base on potential behavioral and physiological effects to marine species from MFAS and underwater detonations. More information about the ICMP may be found in the draft Monitoring Plan for the GoA.

*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 other Navy rules and LOAs (*e.g.,* the Southern California Range Complex (SOCAL), Hawaii Range Complex (HRC), etc.). The Monitoring Workshop participants will 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 will 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 will be applied to monitoring plans as appropriate.

**Adaptive Management**

The final regulations governing the take of marine mammals incidental to Navy training exercises in the GoA TMAA will contain an adaptive management component. Our understanding of the effects of MFAS 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 in the Pacific Ocean). 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 or biennial 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 or biennial LOAs.

The following are some of the possible sources of applicable data: (1) 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; (2) compiled results of Navy funded research and development (R&D) studies (presented pursuant to the ICMP, which is discussed elsewhere in this document); (3) results from specific stranding investigations (involving coincident MFAS or explosives training or not involving coincident use); (4) results from general marine mammal and sound research; and (5) 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.

Separately, in July 2010, NMFS and the Navy convened the "Marine Mammals and Sound" workshop, which brought together science and policy experts from the government, the academic community, and non-governmental organizations with the goals of prioritizing marine mammal research needs and opening up a broad discussion of (and potentially making recommendations regarding) some of the current management issues related to marine mammals and sound. After the information and ideas gathered during this workshop are sorted, compiled, and assessed, NMFS will use them, as appropriate, to inform our management decisions on issues such as appropriate mitigation and monitoring. In addition to considering these workshop products in the broader context of all MMPA authorizations that the Office of Protected Resources, they will also be considered as NMFS and the Navy work through the Adaptive Management process outlined for the GOA below.

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 LOAs. NMFS and the Navy will meet, 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 GoA TMAA 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 the 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; and

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

*Annual GoA TMAA Monitoring Plan Report*

The Navy shall submit a report annually on December 15 describing the implementation and results (April through October of the same year) of the GoA TMAA 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 GoA TMAA 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 GoA TMAA Exercise Report referenced below.

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

*Annual GoA TMAA Exercise Report*

The Navy will submit an Annual GoA TMAA Report on December 15 of every year (covering data gathered from April through October). This report shall contain the subsections and information indicated below.

MFAS/HFAS Training Exercises

This section shall contain the following information for the following Coordinated and Strike Group exercises: Joint Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force TMAA:

(a) *Exercise Information (for each exercise)*

(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 an 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 exercise)*

(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 <200 yd, 200–500 yd, 500–1,000 yd, 1,000–2,000 yd, or >2,000 yd 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 exercises) of the effectiveness of mitigation measures designed to avoid exposing marine mammals to MFAS, that 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 the GoA TMAA. The Navy shall include (in the GoA TMAA 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 GoA TMAA 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 (762 m for SINKEX in the GoA TMAA); (2) the required exclusion zone (1 nm for SINKEX in the GoA TMAA); (3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in the GoA TMAA); and (4) greater than the required observed distance. For example, in this case, the observer would indicate if <762 m, from 762 m to 1 nm, from 1 nm to 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 propsed rule) conducted in the GoA TMAA

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

*GoA TMAA 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 GoA TMAA Exercise Reports and GoA TMAA Monitoring Plan Reports). This report shall be submitted at the end of the fourth year of the rule (December 2014), covering activities that have occurred through October 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 GoA TMAA Comprehensive Report, the Comprehensive National ASW report, the Annual GoA TMAA Exercise Report, or the Annual GoA TMAA 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. The Potential Effects section 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. This section 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 GoA.

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 previous sections, 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 previous sections 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 category. 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 was in the same frequency band as the necessary vocalizations and of a severity that 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) indicates 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 previous sections, 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 (*e.g.,* emboli). 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 an 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 the GoA.

*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 five bottlenose dolphins and two 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 (exposure level (EL) = 192 to 201 dB re 1 $\mu Pa^2$-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μPa and 195 dB re 1 $\mu Pa^2$-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 $\mu Pa^2$-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 $\mu Pa^2$-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 $\mu Pa^2$-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 19–33 dB from behavioral measurements and 40–45 dB 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 were 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 (*e.g.,* 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 (<6 dB) 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 GoA 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 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 20 dB of additional exposure (34 dB divided by 1.6 dB) above onset-TTS to reach PTS. A detailed description of how TTS criteria were derived from the results of the above studies may be found in Chapter 3 of Southall *et al.* (2007), as well as the Navy's GoA 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) does 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 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 three 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-percent 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 percent risk, or the received level at which we believe 50 percent of the animals exposed to the designated received level would respond in a manner that NMFS classifies as Level B Harassment. The K parameter (K = 45 dB) is based on three datasets in which marine mammals exposed to mid-frequency sound sources were reported to respond in a manner that NMFS would classify as Level B Harassment. There is widespread consensus that marine mammal responses to 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 three-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 preliminary results from Phase 2 became available in October 2008. 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 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 the GoA.

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 captive marine mammals trained to perform tasks on command, 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 two separate TTS experiments using 1-sec tones at 3 kHz. The test methods were similar to that of Schlundt *et al.* (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 $\mu Pa^2$/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-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-min signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) Alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to pique the mammalian auditory system with disharmonic signals that cover the whales' estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise); and (c) to provide localization cues for the whale. The maximum source level used was 173 dB SPL.

Nowacek *et al.* (2004) reported that five out of six whales exposed to the alert signal with maximum received levels ranging from 133 to 148 dB re 1 μPa significantly altered their regular behavior and did so in identical fashion. Each of these five whales did the following: (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 1.1 yd (1 m) of the surface.

3. *Odontocete Field Data (Haro Strait—U.S. Ship (USS) SHOUP)*—In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses generally described as avoidance behavior while the 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 the 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 animals upon actual exposure to AN/SQS–53 sonar.

The U.S. Department of Commerce (NMFS, 2005a), U.S. Department of the Navy (2004b), and 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 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 five maximum received levels at which Nowacek *et al.* (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K = 45.

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

The use of a steepness parameter of A = 10 for odontocetes 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 (DoN, 2001c). As concluded in the SURTASS FEIS/EIS, the value of A = 10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme *et al.,* 1984; Buck and Tyack, 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D, and NMFS, 2008).

NMFS determined that a lower steepness parameter (A = 8), resulting in a shallower curve, was appropriate for use with mysticetes and 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.

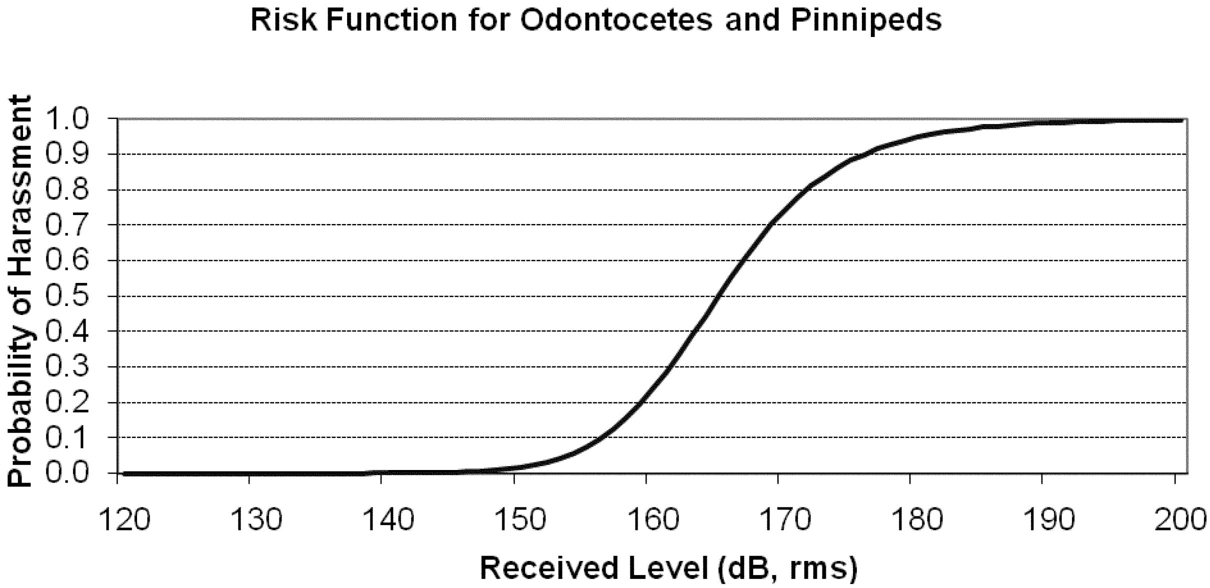


**Figure 1a**. Risk function for odontocetes and pinnipeds. B = 120 dB, K = 45 dB, A = 10

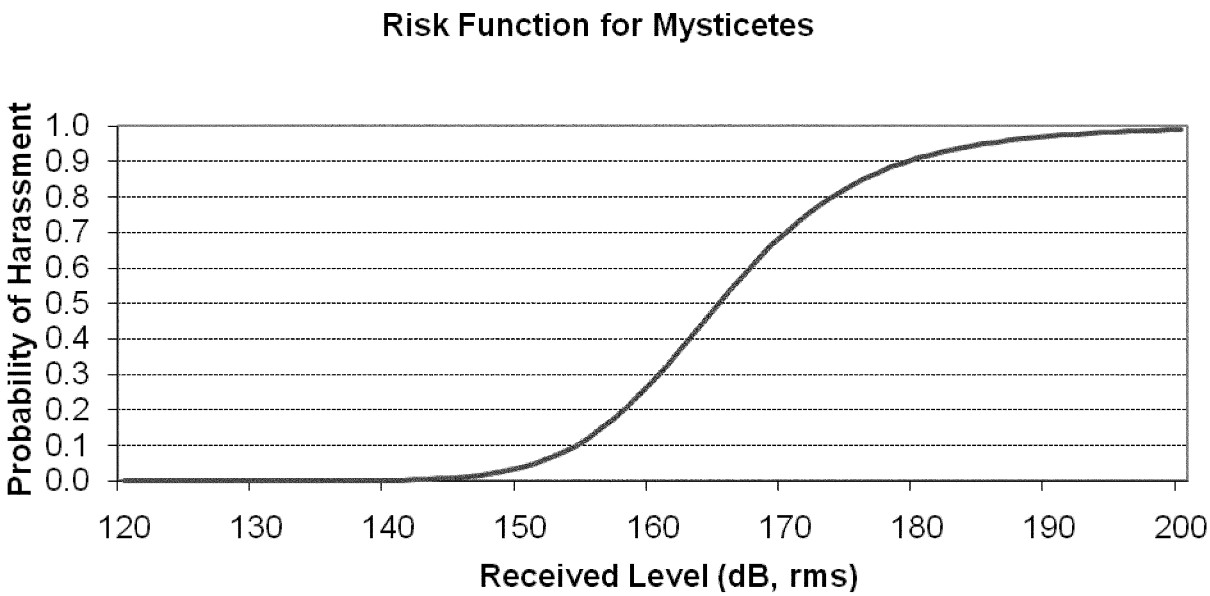


**Figure 1b**. Risk function for mysticetes. B=120 dB, K=45 dB, A=8.

*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 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data primarily used to produce the risk function (the K parameter) were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall *et al.,* 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available. 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 GoA TMAA example, animals exposed to received levels between 120 and 130 dB will likely be 76 to 105 km away from a sound source; 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 responses 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 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 GoA TMAA, the LOA application, and in the Navy's CHURCHILL FEIS (DoN, 2001c).

| 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 either Appendix B of the Navy's Application or Appendix D of the Navy's DEIS.

(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 up to 20 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 surface roughness, as determined by wind speed

• The estimated density of each marine mammal species in the GoA TMAA (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 GoA TMAA, 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 hrs

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 percent. NMFS estimates that a 10-percent increase in active sonar hours would result in approximately a 10-percent 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 of quantitative data, NMFS has, and will continue, to evaluate that sort of information qualitatively.

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| Species | Modeled Sonar Exposures to Indicated Thresholds | | | Modeled Explosive Exposures to Indicated Thresholds | | | | NMFS Proposed Annual Take Authorization | | | 5-Year Proposed 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 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 10 |
| Fin whale | 10,998 | 21 | 0 | 13 | 5 | 0 | 0 | 11,037 | 0 | 0 | 55,185 |
| Humpback whale | 1388 | 6 | 0 | 1 | 0 | 0 | 0 | 1395 | 0 | 0 | 6975 |
| North Pacific right whale | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 10 |
| Sei whale | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 8 | 0 | 0 | 40 |
| Sperm whale | 327 | 1 | 0 | 1 | 0 | 0 | 0 | 329 | 0 | 0 | 1645 |
| Stellar sea lion | 11,104 | 1 | 0 | 2 | 1 | 0 | 0 | 11,108 | 0 | 0 | 55,540 |
| **Mysticetes** | | | | | | | | | | | |
| Gray whale | 384 | 1 | 0 | 3 | 0 | 0 | 0 | 388 | 0 | 0 | 1940 |
| Minke whale | 677 | 2 | 0 | 2 | 0 | 0 | 0 | 681 | 0 | 0 | 3405 |
| **Odontocetes** | | | | | | | | | | | |
| Baird's beaked whale | 485 | 1 | 0 | 1 | 0 | 0 | 0 | 487 | 0 | 15 over the couse of 5-yr rule | 2435 |
| Stejneger's beaked whale | 2302 | 6 | 0 | 4 | 1 | 0 | 0 | 2313 | 0 | | 11,565 |
| Cuvier's beaked whale | 2302 | 6 | 0 | 3 | 1 | 0 | 0 | 2312 | 0 | | 11,560 |
| Dall's porpoise | 205,485 | 768 | 1 | 84 | 37 | 2 | 1 | 206,374 | 0 | 0 | 1,031,870 |
| Harbor porpoise | 5438 | 0 | 0 | 2 | 0 | 0 | 0 | 5440 | 0 | 0 | 27,200 |
| Killer whale | 10,602 | 41 | 0 | 4 | 2 | 0 | 0 | 10,649 | 0 | 0 | 53,245 |
| Pacific white-sided dolphin | 16,912 | 61 | 0 | 12 | 6 | 1 | 0 | 16,991 | 0 | 0 | 84,955 |
| **Pinnipeds** | | | | | | | | | | | |
| California sea lion | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 10 |
| Harbor seal | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 10 |
| Northern elephant seal | 2064 | 0 | 0 | 4 | 1 | 0 | 0 | 2069 | 0 | 0 | 10345 |
| Northern fur seal | 154,144 | 16 | 0 | 26 | 16 | 1 | 0 | 154,202 | 0 | 0 | 771,010 |
| **Total** | **424,620** | **931** | **1** | **170** | **70** | **4** | **1** | **425,791** | **0** | | **2,128,955** |

**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 GoA TMAA, 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 five of these physical factors believed to have contributed to the likelihood of beaked whale strandings are present, in their aggregate, in the GoA TMA, 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 NMFS proposes to authorize take by injury or mortality of up to 15 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 GoA TMAA.

**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 GoA TMAA 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 GoA TMAA 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 GoA TMAA 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, 1992b; 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 and 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 aggregations of zooplankton, krill, and small schooling fish, while toothed whales feed on epipelagic, mesopelagic, and bathypelagic fish and squid. As summarized above and in the GoA TMAA DEIS in more detail, potential impacts to marine mammal food resources within the GoA TMAA are 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 GoA TMAA.

*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 GoA TMAA DEIS.

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 GoA TMAA. 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 GoA TMAA 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 EMATTs.

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 and a much greater amount of Navy training. Therefore, as discussed in the GoA TMAA DEIS, expendable material is highly unlikely to directly affect marine mammal species or potential habitat within the GoA TMAA.

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 GoA TMAA DEIS analyzed the potential effects to water quality from sonobuoy, Acoustic Device Countermeasures (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 (*e.g.,* 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 percent. 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 GoA TMAA.

### *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 qualifies 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–53 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.

TABLE 9—APPROXIMATE PERCENT OF ESTIMATED TAKES THAT OCCUR IN THE INDICATED 10-dB BINS FOR AN/SQS–53 (THE MOST POWERFUL SOURCE)

| Received level (SPL) | Distance at which levels occur in GOA TMAA | Percent of total harassment takes estimated to occur at indicated level |
|---|---|---|
| Below 138 dB | 42 km–105 km | ~0 |
| 138 < Level < 144 dB | 28 km–42 km | < 1 |
| 144 < Level < 150 dB | 17 km–28 km | ~1 |
| 150 < Level < 156 dB | 9 km–17 km | 7 |
| 156 < Level < 162 dB | 5 km–9 km | 18 |
| 162 < Level < 168 dB | 2.5 km–5 km | 26 |
| 168 < Level < 174 dB | 1.2 km–2.5 km | 22 |
| 174 < Level < 180 dB | 0.5 km–1.2 km | 14 |
| 180 < Level < 186 dB | 335 m–0.5 km | 6 |
| 186 < Level < TTS | 178 m–335 m | 5 |
| TTS (195 SEL) | 10 m–178 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)—Continued

| Received level (SPL) | Distance at which levels occur in GOA TMAA | Percent of total harassment takes estimated to occur at indicated level |
|---|---|---|
| PTS (215 SEL) | 10 m | < .01 |

**Note:** 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 GoA TMAA will respond to MFAS/HFAS. The Navy has 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 indicate no behavioral disturbance was 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; preliminary 2008 results are also available). Separately, the Navy and NMFS conducted an opportunistic tagging experiment with several species of marine mammals in the area of the 2008 RIMPAC training exercises in the Hawaii Range Complex (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 hrs or be repeated in subsequent days. 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 hrs). 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 hrs, only two 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 on consecutive days.

*TTS*

NMFS and the Navy have estimated that approximately 1,000 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 9 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:

(1) *Frequency*—Available data (of mid-frequency hearing specialists exposed to mid- or 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 available for each species.

(2) *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 459 ft (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 the GoA TMAA). 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).

(3) *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 the GoA TMAA, 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 (see Communication Impairment Section), though these compensations may incur energetic costs.

*Acoustic Masking or Communication Impairment*

Table 5a and Table 5b are 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 tens of microseconds. 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 Dall's porpoise 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), or 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-m (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 the Navy's modeling predicts that one Dall's porpoise will incur PTS from exposure to MFAS/HFAS, the Navy and NMFS believe it is very unlikely to occur; therefore, the Navy has not requested authorization to take one by Level A Harasssment and NMFS is not proposing to authorize take of Dall's porpoise by Level A harassment.

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 GoA TMAA, which only has a strong surface duct present during the winter, and 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. Lastly, 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 proposes to authorize the injury or mortality of up to 15 beaked whales over the course of the 5-yr regulations.

*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 one exposure of a blue whale to MFAS/HFAS at levels likely to result in Level B harassment will occur, and that one exposure 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; zero TTS takes are estimated. It is unlikely that any blue whales will incur TTS because of the following: 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 of two or three, 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 been seen in the GoA and the Eastern North Pacific population is estimated at a minimum of 1,368 whales. Like most baleen whales, blue whales would most likely feed in the north during summer months (potentially the GoA) and head southward 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 GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, 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 11,019 exposures of fin whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 18 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 26 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.

Although reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not currently available, fin whales have been seen in the GoA and the provisional estimate for this stock is 3,368 whales for the central-eastern Bering Sea and 683 for the eastern Bering Sea. These estimates are considered provisional because they have not been corrected for animals missed on the trackline, animals submerged when the survey ship passed, and responsive movements. For purposes of acoustic impact modeling, a density of 0.010 individuals per $km^2$ was used based on 24 visual observations of fin whale groups totaling 64 individuals during a 10-day period (Rone *et al.,* 2009). Although acoustic impact modeling predicted a large number of takes relative to population size, NMFS believes that this is a conservative estimate due to the high number of fin whales sighted during the most recent survey in 2009. In addition, the majority of fin whale takes by Level B harassment would result in behavioral harassment (99.8 percent), which NMFS, for reasons discussed in the Behavioral Harassment section above, expects will have a negligible impact on the species. For instance, previous monitoring reports submitted by the Navy from more than 60 major exercises have indicated no observed behavioral disturbance Although one cannot conclude from these results that marine mammals were not harassed and some of the non-biologist watchstanders might not be well qualified to characterize behavior, one can say that the animals observed did not respond in any of the obviously more severe ways, such as panic, aggression, or anti-predator response that would be more likely to adversely affect annual rates of recruitment or survival. Additional reasons in support of NMFS' preliminary negligible impact determination follow. In the North Pacific, fin whales migrate seasonally from high Arctic feeding areas in the summer to low latitude breeding and calving areas in the winter. The GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, 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 4 exposures of sei whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that 4 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; no TTS takes are estimated. 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 (three), 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 GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, 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 1,394 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 six TTS takes are also estimated. However, it is unlikely that any humpback whales will incur TTS because of the following: The distance within which they would have to approach the MFAS source (approximately 459 ft (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 one humpback whale would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B 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, before or during exercise 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 (Calambokidis *et al.,* 2008). 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 GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, 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.

North Pacific Right Whale (MMPA Depleted/ESA-Listed)

Acoustic analysis predicts that one exposure of a North Pacific right whale to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that one exposure to explosives will occur. These Level B takes are anticipated to be in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section; no TTS takes are estimated. It is unlikely that any North Pacific right whales will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 459 ft (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, callosities on the head, and pronounced v-shaped blow) and implement active sonar powerdown or shutdown.

North Pacific right whales are found in subpolar to temperate waters. There are no reliable estimates of current abundance or trends for right whales in the North Pacific and the population may only number in the low hundreds (Angliss and Allen, 2008). The population in the eastern North Pacific is considered to be very small, perhaps only in the tens of animals. Over the past 40 years, most sightings in the eastern North Pacific have been of single animals; however, during the last few years, small groups of right whales have been reported (such as the group of 17 documented in the Bering Sea in 2004; Angliss and Allen, 2008). There is evidence that the GoA was historically used as a feeding ground, and recent surveys suggest that some individuals continue to use the shelf east of Kodiak Island as a feeding area, which has now been designated under the ESA as critical habitat (73 FR 19000, April 8, 2008). The North Pacific right 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 North Pacific right 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 679 exposures of minke whales to MFAS/HFAS at sound levels likely to result in Level B harassment will occur, and that two 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. It is somewhat unlikely that any minke whales will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 459 ft (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 distributed in polar, temperate, and tropical waters, but are less common in the tropics than in cooler waters. Within the Pacific EEZ, NMFS recognizes three stocks of minke whales: A California/Oregon/Washington stock; an Alaskan stock; and a Hawaiian stock. Currently, there are no estimates of abundance for minke whales in Alaskan waters (Angliss and Allen, 2008). In general, sightings of minke whales in the GoA are low. Although large numbers of minke whales were reported at Portlock Bank (in the TMAA) and Albatross bank (west of the TMAA) in May 1976 (Fiscus *et al.,* 1976), subsequent NMFS surveys reported no minke whales in those locations. During the April 2009 survey, two encounters totaling three individual minke whales occurred on the shelf and only one of these encounters was within the TMAA. The GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, 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 328 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; one TTS take is estimated and proposed for authorization. However, it is unlikely that any sperm whales will incur TTS because of: The distance within which they would have to approach the MFAS source (approximately 459 ft (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, pronounced blow, and mean group size of seven).

The acoustic analysis further predicts that one sperm whale would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment. NMFS believes that this is unlikely because of: The distance within which they would have to approach the explosive source; and the likelihood that Navy monitors would, before or during exercise 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, and are broadly distributed from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Currently, estimates of sperm whale abundance in the North Pacific are not available. For the North Pacific, sperm whales have been divided into three separate stocks based on where they are found, which have been designated as (1) Alaska (North Pacific stock), (2) California/Oregon/Washington, and (3) Hawaii (Angliss and Allen, 2008). The estimated population for the North Pacific stock is 102,112 (CV = 0.15) (Angliss and Allen, 2008). In the GoA, sperm whales primarily occur seaward of the 1,640 ft (500 m) isobath (DoN, 2006). A survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and between Kodiak and Montique Island from June 26 to July 15, 2003 detected six sperm whales along the shelf break, with an average group size of 1.2 (Waite 2003). The April 2009 survey in the TMAA recorded sperm whales acoustically in both the inshore and offshore strata, but no sperm whales were detected visually (Rone *et al.,* 2009). 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.

Gray Whale

Acoustic analysis predicts that 385 exposures of gray 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; one TTS take is estimated. NMFS believes that it is unlikely that a gray whale will incur TTS because of the distance within which they would have to approach the MFAS source (approximately 459 ft (140 m) for the most powerful source for TTS) and the fact that many animals will likely avoid active sonar sources to some degree. The gray whales' 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 gray whales.

The acoustic analysis further predicts that three gray whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment. 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.

Gray whales occur only in the North Pacific. The Eastern North Pacific (ENP) population is found from the upper Gulf of California, south to the tip of Baja California, and up the Pacific coast of North America to the Chukchi and Beaufort seas. This stock is known to summer in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea, but some individuals spend the summer feeding along the Pacific coast from southeastern Alaska to central California. The minimum population estimates for the ENP stock of gray whales using the mean of the 2000/01 and 2001/02 abundance estimates is 17,752 and the best estimate of 18,813 whales (CV = 0.07; Angliss and Allen, 2008). The April 2009 survey encountered one group of two gray whales within the western edge of the TMAA and two groups well outside the TMAA, nearshore at Kodiak Island (Rone *et al.,* 2009). The GoA TMAA activities are not expected to occur in an area/time of specific importance for breeding, calving, or other known critical behaviors. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of gray 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 486 Baird's beaked whales, 2,308 Cuvier's beaked whales, and 2,308 Stejneger'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; one, six, and six (respectively, by species) TTS takes are 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 459 ft (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 5a and Table 5b, some beaked whale vocalizations might overlap with the MFAS/HFAS TTS frequency range (2 to 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 one Cuvier's beaked whale and one Stejneger's beaked whale would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and one Baird's beaked whale, three Cuvier's beaked whales, and four Stejneger's beaked whales could be exposed to levels associated with behavioral disturbance. It is important to note that, due to the lack of available density information for Stejneger's beaked whale, the density and results from modeling of Cuvier's beaked whales were used as a surrogate.

Baird's beaked whales appear to occur mainly in cold deep water (3,300 ft (1,000 m) or greater) over the continental slope, oceanic seamounts, and in areas with submarine escarpments. They may also occasionally occur near shore along narrow continental shelves. The range for the Alaska stock of Baird's beaked whale extends from Cape Navarin (63 °N lat.) and the central Sea of Okhotsk (57 °N lat.) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern GoA (Angliss and Allen, 2008; DoN, 2006). Waite (2003) reported a group of four Baird's beaked whales at the shelf break to the east of the TMAA. There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the 2009 survey of the TMAA (Rone *et al.,* 2009).

Cuvier's beaked whales are considered to be the most widely distributed of the beaked whales. They occur in all three major oceans and most seas. In the North Pacific, they range north to the northern GoA, the Aleutian Islands, and the Commander Islands and as far south as Hawaii. In general, Cuvier's beaked whales are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded in areas with depths of 3,281 ft (1,000 m) or deeper. Occurrence has been linked to physical features such as the continental slope, canyons, escarpments, and oceanic islands (Angliss and Outlaw, 2005). Waite (2003) reported one sighting of a group of four Cuvier's beaked whales at the shelf break within the TMAA. Other reports of Cuvier's beaked whales in the GoA were in very deep water. Rice and Wolman (1982) observed a group of six Cuvier's beaked whales in about 14,715 ft (5,400 m) of water southeast of Kodiak Island. Surveys in the Aleutian Islands observed a group of six Cuvier's beaked whales in waters with a bottom depth of 13,123 to 16,404 ft (4,000 to 5,000 m) (Forney and Brown, 1996).

Stejneger's beaked whales (also called Bering Sea beaked whales) are found only in the North Pacific and appear to prefer cold-temperate and subpolar waters. The Alaska stock is recognized as separate from the population off California (Angliss and Outlaw, 2007). Off Alaska, this species has been observed in waters ranging from a bottom depth ranging from 2,395 to 5,118 ft (730 to 1,560 m) on the steep slope of the continental shelf as it drops off into the Aleutian Basin (which exceeds 11,482 ft (3,500 m) in bottom depth) (DoN, 2006). Although the April 2009 survey in the TMAA detected no beaked whales, surveys in the central Aleutian Islands sighted groups of three to 15 Stejneger's beaked whales (Rice, 1986).

No abundance estimates are available for any of these three species of beaked whale. There is only a limited amount of information pertaining to the life history of beaked whales. Scientists have gathered some information from stranded animals, but little is known about how these animals express their life histories in the wild. Moreover, most sightings of beaked whales are brief because these whales are often difficult to approach and they actively avoid aircraft and vessels (*e.g.,* Wursig *et al.,* 1998). For the Stejneger's beaked whale, for example, there is no available information on reproduction and breeding. As discussed above, correlations have been made between bathymetric features and beaked whale sightings, which may indicate a habitat preference. The GoA TMAA 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.

Killer Whale (AT1 Transient Stock MMPA Depleted)

Acoustic analysis predicts that 10,643 killer 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; 41 TTS takes are estimated. NMFS, for reasons discussed in the Behavioral Harassment section above, expects that these takes will have a negligible impact on the species. For instance, previous monitoring reports submitted by the Navy from more than 60 major exercises have indicated no observed behavioral disturbance. Although one cannot conclude from these results that marine mammals were not harassed and some of the non-biologist watchstanders might not be well qualified to characterize behavior, one can say that the animals observed did not respond in any of the obviously more severe ways, such as panic, aggression, or anti-predator response that would be more likely to adversely affect annual rates of recruitment or survival. With respect to the TTS takes, 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 459 ft (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 5a and Table 5b, vocalizations of these species might overlap with the MFAS/HFAS TTS frequency range (2 to 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 two killer whales would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and four 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.

Killer whales have the most ubiquitous distribution of any marine mammal species, observed in virtually every marine habitat from the tropics to the poles and from shallow, inshore water (and even rivers) to deep, oceanic regions. In the eastern north Pacific, including Alaskan waters, killer whales are found in protected inshore waters, as well as offshore waters (DoN, 2006). Killer whales are segregated socially, genetically, and ecologically into three distinct eco-type groups: Residents, transients, and offshore animals; all three eco-types are represented in the GoA. The ENP Alaskan Resident stock ranges from southeastern Alaska to the Aleutian Islands and Bering Sea. The ENP Northern Resident stock occurs from British Columbia through part of southeastern Alaska. There are about 656 and 216 photo-identified individuals in the ENP Alaska Resident and ENP Northern Resident stocks, respectively (Angliss and Allen, 2008).

The minimum population estimate for the GoA, Aleutian Islands, and Bering Sea Transient stock is 314 individuals based on photo-identification work. There is a minimum population estimate of 320 individuals in the West Coast Transient stock, which includes about 225 in Washington State and British Columbia, and southeastern Alaska, and 105 off California. The population estimate for the ENP stock of Transient whales is 346. The minimum population estimate for the AT1 Transient stock is seven individuals based on photographs from recent years (Angliss and Allen, 2008).

The minimum population estimate for the ENP Offshore stock of killer whales is 1,214 individuals (Carretta *et al.,* 2007). The total number of known offshore killer whales is 211 individuals, but the amount of time this transboundary stock spends in U.S. waters is unknown (Carretta *et al.,* 2006).

The GoA TMAA 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 three eco-types of killer 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.

Pacific White-Sided Dolphins

Acoustic analysis predicts that 16,973 Pacific white-sided dolphins will be exposed to MFAS/HFAS at sound levels likely to result in Level B harassment. 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; 61 TTS takes are 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 459 ft (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 5a and Table 5b, vocalizations of these species might overlap with the MFAS/HFAS TTS frequency range (2 to 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 six Pacific white-sided dolphins would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and 12 could be exposed to levels associated with behavioral disturbance. NMFS believes that this is unlikely because of: The distance within which they would have to approach the explosive source; and the likelihood that Navy monitors would, before or during exercise monitoring, detect these large-grouped gregarious animals prior to an approach within this distance and require a delay of the exercise.

Pacific white-sided dolphins occur across the central north Pacific waters to latitudes as low as (or lower than) 38 °N and northward to the Bering Sea and coastal areas of southern Alaska. In the eastern north Pacific, the species occurs from the southern Gulf of California, north to the GoA, west to Amchitka in the Aleutian Islands, and is rarely encountered in the southern Bering Sea. Pacific white-sided dolphins occur regularly year-round throughout the GoA. They are widely distributed along the shelf break, continental slope, and in offshore waters. In Alaska, peak abundance is between July and August, when Pacific white-sided dolphins tend to congregate near the Fairweather Grounds in the southeastern GoA and Portlock Bank in the northeast part of the TMAA (Angliss and Allen, 2008; DoN, 2006). The minimum population estimate for the North Pacific stock is 26,880 (CV = 0.90) individuals (Angliss and Allen, 2008).

The GoA TMAA 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 Pacific white-sided 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 this species.

Porpoises

The acoustic analysis predicts that the following numbers of Level B behavioral harassments of the associated species will occur: 206,374 Dall's porpoises and 5,440 harbor porpoises. This estimate represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year.

Although a portion (768 Dall's porpoises) of the modeled Level B Harassment takes for these species is predicted to be in the form of TTS from MFAS, NMFS believes it is unlikely that all of the individuals estimated will incur TTS because of the distance within which they would have to approach the active sonar source (approximately 459 ft (140 m) for the most powerful source), 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 and implement active sonar powerdown or shutdown. Navy lookouts will likely detect a group of dolphins given their relatively short dives, gregarious behavior, and large average group size. 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 5a and Table 5b, some porpoise vocalizations might overlap with the MFAS/HFAS TTS frequency range (2 to 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.

Acoustic analysis also predicted that 37 Dall's porpoises would be exposed to sound or pressure from explosives at levels expected to result in TTS. For the same reasons noted above, NMFS anticipates that the Navy watchstanders would likely detect these species and implement the mitigation to avoid exposure. However, the range to TTS for a few of the larger explosives is larger than the associated exclusion zones for BOMBEX, MISSILEX, or SINKEX (see Table 3), and therefore NMFS anticipates that TTS might not be entirely avoided during those exercises.

Acoustic analysis also predicted that three Dall's porpoises might be exposed to sound or pressure from sonar (one) and explosive detonations (two) that would result in PTS or injury. In addition, the analysis predicted that one Dall's porpoise mortality may occur as a result of exposure to pressure/energy levels from explosive detonations. For the same reasons listed above (group size, dive and social behavior), NMFS anticipates that the Navy watchstanders would detect these species and implement the mitigation measures to avoid exposure. In the case of all explosive exercises, the exclusion zones are 2–12 times larger than the estimated distance at which an animal would be exposed to injurious sounds or pressure waves.

No areas of specific importance for reproduction or feeding for porpoises have been identified in the GoA TMAA. Table 4 shows the estimated abundance of the affected porpoise stocks.

Based on the general information contained in the Negligible Impact Analysis section and this stock-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.

Steller Sea Lion (MMPA Depleted/ESA-Listed)

The risk function and Navy post-modeling analysis estimates that 11,106 Steller sea lions would be exposed to non-TTS (behavioral) Level B harassment, two Steller sea lions would be exposed to TTS Level B harassment and no Steller sea lions would be exposed to Level A harassment (11,105 from sonar and three from at-sea explosions). 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 the year. The short duration and intermittent transmission of the sonar signals, combined with relatively rapid vessel speed, reduces the likelihood that exposure to sonar sound would cause a behavioral response that may affect vital functions, TTS, or PTS. The set-up procedures and checks required for safety of event participants make it unlikely that Steller sea lions would remain in an area undetected before explosive detonation occurred.

The minimum abundance estimate for the western U.S. stock of Steller sea lions is 38,988 individuals and for the Eastern stock is 45,095 to 55,832 (Angliss and Allen, 2008). Given the wide dispersal of individuals, both the western and eastern U.S. stocks may occur in the GoA (DoN, 2006; Angliss and Outlaw, 2007; NMFS, 2008), with about 70 percent of the population living in Alaskan waters. Relative to the population size, the Navy's activities are anticipated to result only in a limited number of Level B harassment takes. For the GoA, foraging habitat is primarily shallow, nearshore, and continental shelf waters 4.3 to 13 nm (8 to 24 km) offshore with a secondary occurrence inshore of the 3,289 ft (1,000 m) isobaths, and a rare occurrence seaward of the 3,280 ft (1,000 m) isobaths. Steller sea lions have been sighted foraging in the middle of the GoA (DoN, 2006). The April 2009 survey in the TMAA encountered two groups of Steller sea lions (Rone *et al.,* 2009). No aquatic foraging critical habitat exists within the TMAA. Steller sea lions form large rookeries during late spring and most births occur from mid-May through mid-July outside the boundaries of the TMAA. There are no known areas used by Steller sea lions for reproduction or calving within the TMAA. 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.

California Sea Lion

There are not sufficient numbers of California sea lions present in the TMAA to allow for acoustic impact modeling. Even if an accurate abundance or density could be derived for these species, being so few in number in the TMAA, accepted modeling methodology would predict zero exposures. Therefore, for each proposed 21-day exercise period, the number of behavioral harassments will be based on an assumption of having exposed the average group size to one instance of behavioral harassment to account for all acoustic sources for purposes of this analysis in the TMAA. It is assumed, given that California sea lions are very rare in the GoA, that they would only be encountered individually (*i.e.,* average group size of one) even if a prey species was running. In order to account for rare animals, the Navy requests authorization to take two California sea lions by non-TTS Level B harassment. No TTS Level B harassment or Level A harassment is anticipated.

The abundance estimate for the U.S. stock of California sea lions is 238,000 individuals (Carretta *et al.,* 2007b). This number is from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in Southern California and at haulout sites north to the Oregon/California border. The few California sea lions recorded in Alaska are usually observed at Steller sea lion rookeries and haulout sites with most sightings recorded between March and May, although they may be found in the GoA throughout the year (Maniscalco *et al.,* 2004; DoN, 2006). During August and September, after the mating season, adult male California sea lions migrate to feeding areas as far north as the GoA (Lowry *et al.,* 1991). They remain there until spring (March-May), when they migrate southward to the breeding colonies. The GoA is outside of the known breeding range for California sea lions. There are no known areas used by California sea lions for reproduction or calving in the TMAA. 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.

Harbor Seal

The Navy's acoustic analysis estimates that one harbor seal would be exposed to MFAS/HFAS at sound levels likely to result in Level B harassment. This Level B take is anticipated to be in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section; no TTS takes are estimated.

The acoustic analysis further predicts that one harbor seal would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment. This Level B take is also anticipated to be in the form of behavioral disturbance and no TTS takes are estimated from exposure to levels of pressure and/or energy from explosive detonations.

The population estimate for the Gulf of Alaska stock of harbor seals is 45,975 (CV = 0.04) (Angliss and Allen, 2008). The harbor seal is one of the most widespread of the pinniped species distributed from the eastern Baltic Sea, west across the Atlantic and Pacific Oceans to southern Japan, along the coast and offshore islands of the GoA (DoN, 2006). With few exceptions, harbor seals in the GoA are located in shallow nearshore areas and not at sea in the TMAA. Harbor seals, therefore, should be very rare in the small section of the TMAA nearest Kenai Peninsula, Montague Island, and Middleton Island. During the April 2009 survey, no harbor seals were encountered within the TMAA (Rone *et al.,* 2009). There are harbor seal haulouts along the shoreline of southeast Alaska, the south side of the Alaska Peninsula, the Aleutian Islands, and Middleton and Montague Islands (Hoover, 1988; Lowrey *et al.,* 2001; Boveng *et al.,* 2003). However, there are no known preferred habitat areas used by harbor seals within the TMAA. 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.

Northern Elephant Seal

The Navy's acoustic analysis estimates that 2,064 northern elephant seals would 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 the year. These Level B takes are anticipated to be in the form of behavioral disturbance as described in the Definition of Harassment: Level B Harassment section, and no TTS takes are estimated from exposure to MFAS/HFAS.

The acoustic analysis further predicts that one northern elephant seal would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, and four could be exposed to levels associated with behavioral disturbance. NMFS believes it unlikely that a northern elephant seal will incur TTS because of: The distance within which they would have to approach to explosive source; and the likelihood that Navy monitors would, during pre-exercise monitoring or while an exercise is taking place, detect these pinnipeds (because of the relatively short duration of their dives and their tendency to rest near the surface) prior to an approach within this distance and implement the appropriate mitigation measures.

The population estimate for the California Breeding stock of northern elephant seals is 124,000 (Carretta *et al.,* 2007). Northern elephant seals are endemic to the North Pacific Ocean, occurring almost exclusively in the eastern and central North Pacific. Individuals from the California breeding stock do occur regularly in the GoA year-round (Calkins, 1986). Typically, only sub-adult and adult male elephant seals forage in the GoA with a peak abundance in the spring and fall (Le Boeuf *et al.,* 2000). There are no known areas used by northern elephant seals for reproduction or calving in the TMAA. 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.

Northern Fur Seal (Eastern Pacific Stock MMPA Depleted)

The Navy's acoustic analysis estimates that 154,160 northern fur seals would 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 the 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 16 TTS takes are estimated from exposure to MFAS/HFAS. NMFS believes it unlikely that a northern fur seals, for which the TTS threshold is 206 dB SEL, will incur TTS because of the distance within which they would have to approach the MFAS source (approximately 121 ft (37 m) for the most powerful source), the fact that many animals will likely avoid active sonar sources to some degree, and the likelihood that Navy monitors would detect these pinnipeds (because of the relatively short duration of their dives and their tendency to rest near the surface) prior to an approach within this distance and implement active sonar powerdown or shutdown. In addition, some northern fur seal vocalizations might overlap with the MFAS/HFAS TTS frequency range (2 to 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 16 northern fur seals would be exposed to levels of pressure and/or energy from explosive detonations that would result in Level B harassment by TTS, 26 could be exposed to levels associated with behavioral disturbance, and one Level A harassment may occur. NMFS believes it unlikely that a northern fur seal will be subject to Level A harassment or incur TTS because of: The distance within which they would have to approach to explosive source; and the likelihood that Navy monitors would, during pre-exercise monitoring or while an exercise is taking place, detect these pinnipeds (because of the relatively short duration of their dives and their tendency to rest near the surface) prior to an approach within this distance and implement the appropriate mitigation measures.

The population estimate for the Eastern Pacific stock of northern fur seals is 665,550 (Angliss and Allen, 2008). Northern fur seals are a highly oceanic species spending all but 35 to 45 days per year at sea. They are usually sighted 70 to 130 km from land along the continental shelf and slope, seamounts, submarine canyons, and sea valleys, where there are upwellings of nutrient-rich water. The Eastern Pacific stock spends May through November inwaters and breeding colonies north of the GoA. In late November, females and young begin to arrive in offshore waters off California while adult males migrate only as far south as the GoA (Kajimura, 1984). Peak abundance in the TMAA should occur between March and June during the annual migration north to the Pribilof Islands breeding grounds (Fiscus *et al.,* 1976; Consiglieri *et al.,* 1982). However, some northern fur seals, particularly juvenile males and nonpregnant females, remain in the GoA throughout the summer and have been documented in the nearshore waters of Southeastern Alaska, Prince William Sound, Portlock Bank, and the middle of the GoA (Calkins, 1986; Fiscus *et al.,* 1976). Tagging data presented by Ream *et al.* (2005) indicate that the main foraging areas and the main migration route through the GoA are located far to the west of the TMAA. There are no known rookeries or haulout sites areas used by northern fur seals for reproduction or pupping in the vicinity of the TMAA. 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.

## 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 GoA TMAA 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 GoA TMAA would not have an unmitigable adverse impact on the availability of the affected species or stocks for subsistence use. The tribes nearest the GoA TMAA include the Alutiiq, Eyak, and Tlingit groups; however, these tribes do not use the TMAA for subsistence. In March 2008, letter were sent to 12 tribes, including those listed above, by the Navy's Alaskan Command and Elemendorf Air Force Base requesting government-to-government consultation pursuant to Executive Order 13175. All 12 tribes indicated that they have no concerns over the proposed action as described in the GoA TMAA DEIS. The Navy will continue to keep the tribes informed of the timeframes of future joint training exercises.

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 eight marine mammal species under NMFS jurisdiction that are listed as endangered or threatened under the ESA with confirmed or possible occurrence in the TMAA: Cook Inlet beluga whale, North Pacific right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and Steller sea lion. Typically, the Cook Inlet beluga whale does not leave Cook Inlet, which is approximately 70 nm (129.6 km) from the nearest edge of the TMAA. Based on this information, Cook Inlet beluga whales are considered extralimital to the TMAA and will not be considered further for analysis under the MMPA and the Navy has concluded that the proposed action will have no effect on Cook Inlet beluga whales. If NMFS concurs with this determination, for the remaining seven species, the Navy will consult with NMFS 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 GoA TMAA 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 GoA TMAA, which was published on December 11, 2009. 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 regulations and an LOA for GoA TMAA. If the Navy's FEIS is deemed inadequate, 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 not significant for purposes of Executive Order 12866.

Pursuant to the Regulatory Flexibility Act (RFA), 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 RFA requires Federal agencies to prepare an analysis of a rule's impact on small entities whenever the agency is required to publish a notice of proposed rulemaking. However, a Federal agency may certify, pursuant to 5 U.S.C. 605 (b), that the action will not have a significant economic impact on a substantial number of small entities. The Navy is the sole entity that will be affected by this rulemaking, not a small governmental jurisdiction, small organization, or small business, as defined by the 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, Sonar, Transportation.

Dated: October 1, 2010.

**Eric C. Schwaab,**

*Assistant Administrator for Fisheries, National Marine Fisheries Service.*

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

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

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

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

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

**Subpart M—Taking and Importing Marine Mammals; U.S. Navy's Gulf of Alaska Temporary Maritime Activities Area (GoA TMAA)**



## Subpart M—Taking and Importing Marine Mammals; U.S. Navy's Gulf of Alaska Temporary Maritime Activities Area (GoA TMAA)

### § 218.120 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 may be authorized in a Letter of Authorization (LOA) only if it occurs within the Gulf of Alaska Temporary Maritime Activities Area (GoA TMAA) (as depicted in Figure 1–1 in the Navy's application for GoA TMAA), which is bounded by a hexagon with the following six corners: 57°30′ N. lat., 141°30′ W. long.; 59°36′ N. lat., 148°10′ W. long.; 58°57′ N. lat., 150°04′ W. long.; 58°20′ N. lat., 151°00′ W. long.; 57°16′ N. lat., 151°00′ W. long.; and 55°30′ N. lat, 142°00′ W. long.

(c) The taking of marine mammals by the Navy may be authorized in an LOA only 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 percent):

(i) AN/SQS–53 (hull-mounted active sonar)—up to 2,890 hours over the course of 5 years (an average of 578 hours per year);

(ii) AN/SQS–56 (hull-mounted active sonar)—up to 260 hours over the course of 5 years (an average of 52 hours per year);

(iii) AN/SSQ–62 (Directional Command Activated Sonobuoy System (DICASS) sonobuoys)—up to 1,330 sonobuoys over the course of 5 years (an average of 266 sonobuoys per year);

(iv) AN/AQS–22 (helicopter dipping sonar)—up to 960 "dips" over the course of 5 years (an average of 192 "dips" per year);

(v) AN/BQQ–10 (submarine hull-mounted sonar)—up to 240 hours over the course of 5 years (an average of 48 hours per year);

(vi) MK–48 (torpedo)—up to 10 torpedoes over the course of 5 years (a maximum of 2 torpedoes per year);

(vii) AN/SSQ–110A (IEER)—up to 400 buoys deployed over the course of 5 years (an average of 80 per year maximum combined use of AN/SSQ–110A or AN/SSQ–125);

(viii) AN/SSQ–125 (MAC)—up to 400 buoys deployed over the course of 5 years (an average of 80 per year maximum combined use of AN/SSQ–110A or AN/SSQ–125);

(ix) Range Pingers—up to 400 hours over the course of 5 years (an average of 80 hours per year);

(x) SUS MK–84—up to 120 devices over the course of 5 years (an average of 24 per year); and

(xi) PUTR Transponder—up to 400 hours over the course of 5 years (an average of 80 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 (Net Explosive Weight (NEW)):

(A) 5″ Naval Gunfire (9.5 lbs NEW);

(B) 76 mm rounds (1.6 lbs NEW);

(C) Maverick (78.5 lbs NEW);

(D) MK–82 (238 lbs NEW);

(E) MK–83 (238 lbs NEW);

(F) MK–83 (574 lbs NEW);

(G) MK–84 (945 lbs NEW);

(H) MK–48 (851 lbs NEW);

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

(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 180 exercises over the course of 5 years (an average of 36 per year);

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

(D) Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) Systems—up to 400 deployments over the course of 5 years (an average of 80 per year);

(E) Missile exercises (A–S MISSILEX)—up to 20 exercises over the course of 5 years (an average of 4 per year).

(d) The taking of marine mammals may also be authorized in an LOA for the activities and sources listed in § 218.120(c) should the amounts (*i.e.,* hours, dips, number of exercises) vary from those estimated in § 218.120(c), provided that the variation does not result in exceeding the amount of take indicated in § 218.122.

**§ 218.121 [Reserved]**

**§ 218.122 Permissible methods of taking.**

(a) Under Letters of Authorization issued pursuant to §§ 216.106 and 218.127 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 § 218.120(b), provided the activity is in compliance with all terms, conditions, and requirements of these regulations and the appropriate Letter of Authorization.

(b) The activities identified in § 218.120(c) must be conducted in a manner that minimizes, to the greatest extent practicable, any adverse impacts on marine mammals and their habitat.

(c) The incidental take of marine mammals under the activities identified in § 218.120(c) is limited to the species listed below in paragraphs (c)(4), (5), and (6) of this section by the indicated method of take and the indicated number of times (estimated based on the authorized amounts of sound source operation), but with the following allowances for annual variation in activities:

(1) In any given year, annual take, by harassment, of any species of marine mammal may not exceed the amount identified in paragraphs (c)(4) and (5) of this section, for that species by more than 25 percent (a post-calculation/estimation of which must be provided in the annual LOA application);

(2) In any given year, annual take by harassment of all marine mammal species combined may not exceed the estimated total of all species combined, indicated in paragraphs (c)(4) and (5) of this section, by more than 10 percent; and

(3) Over the course of the effective period of this subpart, total take, by harassment, of any species may not exceed the 5-year amounts indicated in paragraphs (c)(4) and (5) of this section by more than 10 percent. A running calculation/estimation of takes of each species over the course of the years covered by the rule must be maintained.

(4) Level B Harassment:

(i) Mysticetes:

(A) Humpback whale (*Megaptera novaeangliae*)—6,975 (an average of 1,395 annually);

(B) Fin whale (*Balaenoptera physalus*)—55,185 (an average of 11,037 annually);

(C) Blue whale (*Balaenoptera musculus*)—10 (an average of 2 annually);

(D) Sei whale (*Balaenoptera borealis)*—40 (an average of 8 annually);

(E) Minke whale (*Balaenoptera acutorostrata*)—3,405 (an average of 681 annually);

(F) Gray whale (*Eschrichtius robustus*)—1,940 (an average of 388 annually); and

(G) North Pacific right whale (*Eubalaena japonica*)—10 (an average of 2 annually).

(ii) Odontocetes:

(A) Sperm whales (*Physeter macrocephalus*)—1,645 (an average of 329 annually);

(B) Killer whale (*Orcinus orca*)—53,245 (an average of 10,649 annually);

(C) Harbor porpoise (*Phocoena phocoena*)—27,200 (an average of 5,440 annually);

(D) Baird's beaked whales (*Berardius bairdii*)—2,435 (an average of 487 annually);

(E) Cuvier's beaked whales (*Ziphius cavirostris*)—11,560 (an average of 2,312 annually);

(F) Stejneger's beaked whales (*Mesoplodon stejnegeri*)—11,565 (an average of 2,313 annually);

(G) Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)—84,955 (an average of 16,991 annually); and

(H) Dall's porpoise (*Phocoenoides dalli*)—1,031,870 (an average of 206,374 annually).

(iii) Pinnipeds:

(A) Steller sea lion (*Eumetopias jubatus*)—55,540 (an average of 11,108 annually)

(B) California sea lion (*Zalophus californianus*)—10 (an average of 2 annually);

(C) Harbor seal (*Phoca vitulina richardsi*)—10 (an average of 2 annually);

(D) Northern elephant seal (*Mirounga angustirostris*)—10,345 (an average of 2,069 annually); and

(E) Northern fur seal (*Callorhinus ursinus*)—771,010 (an average of 154,202 annually).

(5) Level A Harassment and/or mortality of no more than 15 beaked whales (total), of any of the species listed in § 218.122(c)(1)(ii)(D) through (F) over the course of the 5-year regulations.

**§ 218.123 Prohibitions.**

No person in connection with the activities described in § 218.120 may:

(a) Take any marine mammal not specified in § 218.122(c);

(b) Take any marine mammal specified in § 218.122(c) other than by incidental take as specified in §§ 218.122(c)(1), (c)(2), and (c)(3);

(c) Take a marine mammal specified in § 218.122(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 218.127 of this chapter.

**§ 218.124 Mitigation.**

(a) When conducting training and utilizing the sound sources or explosives identified in § 218.120(c), the mitigation measures contained in a Letter of Authorization issued under §§ 216.106 and 218.127 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) 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 shall 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 shall 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 shall 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” (20×110) 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.

(xi) Naval vessels shall maneuver to keep at least 1,500 ft (500 yd or 457 m) away from any observed whale in the vessel’s path and avoid approaching whales head-on. These requirements do not apply if a vessel’s safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged activities, launching and recovering aircraft or landing craft, minesweeping activities, replenishment while underway and towing activities that severely restrict a vessel’s ability to deviate course. Vessels shall take reasonable steps to alert other vessels in the vicinity of the whale. Given rapid swimming speeds and maneuverability of many dolphin species, naval vessels would maintain normal course and speed on sighting dolphins unless some condition indicated a need for the vessel to maneuver.

(3) Operating Procedures (for Anti-submarine Warfare (ASW) 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 shall 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 yd (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 yd (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yd (183 m) after pinging has begun.

(x) Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yd (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–53 and 219 for AN/SQS–56, 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 1,000-yd (914 m) exclusion zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1,829 m) beyond the location of the last detection.

(B) Should a marine mammal be detected within 500 yd (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–53 and 215 for AN/SQS–56, 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 (457 m) safety zone (at which point the 6–dB powerdown applies until the animal leaves the 1,000-yd (914 m) safety zone), has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 m) beyond the location of the last detection.

(C) Should the marine mammal be detected within 200 yd (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 (183 m) safety zone (at which point the 10–dB or 6–dB powerdowns apply until the animal leaves the 500-yd (457 m) or 1,000-yd (914 m) safety zone, respectively), has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 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 shall 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 shall 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 is 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) 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) shall 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), shall 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 shall 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 shall be maintained throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE shall be informed of any aural detection of marine mammals and shall 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 shall 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 shall 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 can be adequately monitored visually. Should low cloud cover or surface visibility prevent adequate visual monitoring as described previously, the exercise shall be delayed until conditions improved, and all of the above monitoring criteria can 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.

(5) 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 shall immediately notify the firing vessel, which shall suspend the exercise until the area is clear.

(ii) A 600-yd (585 m) radius buffer zone shall be established around the intended target.

(iii) 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. 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 shall be conducted only when the buffer zone is visible and marine mammals are not detected within it.

(6) 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.

(7) Surface-to-Air Gunnery (Explosive and Non-explosive Rounds):

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

(ii) Vessels shall expedite the attempt to recover 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 shall immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

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

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

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

(iii) Aerial surveillance of the buffer zone for marine mammals shall be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 ft to 1,500 ft (152–456 m) is optimum. Aircraft crew/pilot shall 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 shall be conducted only if marine mammals are not visible within the buffer zone.

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

(10) 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 yd (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 (457 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," shall clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes shall 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 shall assure it has visual site of the target area at a maximum height of 1,500 ft (457 m). The clearing plane shall 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 shall be conducted only if marine mammals are not visible within the buffer zone.

(11) Air-to-Surface At-Sea Bombing Exercises (Non-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 yd (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 (457 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," shall 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 shall assure it has visual site of the target area at a maximum height of 1,500 ft (457 m). The clearing plane shall 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 shall be conducted only if marine mammals and are not visible within the buffer zone.

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

(i) Aircraft shall visually survey the target area for marine mammals. Visual inspection of the target area shall be made by flying at 1,500 ft (457 m) or lower, if safe to do so, and at the 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 yd (1646 m) of sighted marine mammals.

(13) Aircraft Training Activities Involving Non-Explosive Devices: Non-explosive devices such as some sonobuoys and inert bombs 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.

(14) 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 500 yd (457 m) 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) shall be deployed within 1,000 yd (914 m) 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 1,000 yd (914 m) 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 1,000 yd (914 m) 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 1,000-yd (914 m) safety buffer. Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000-yd (914 m) 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 shall ensure that a 1,000-yd (914 m) 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 shall 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 cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

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

(15) The Navy shall abide by the letter of the "Stranding Response Plan for Major Navy Training Exercises in the GoA TMAA" (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 GoA TMAA), the Navy shall implement the procedures described below.

(A) The Navy shall implement a Shutdown (as defined in the Stranding Response Plan for GoA TMAA) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the GoA TMAA Stranding Communication Protocol that a USE (as defined in the Stranding Response Plan for the GoA TMAA) 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 the 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 behavior(s) (if alive), and photo or video of the animal(s) (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: qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or 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 hrs of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the GoA TMAA 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 hrs prior to the USE event. Information not initially available regarding the 80 nm (148 km) and 72 hrs 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]

**§ 218.125 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 shall provide NMFS with the 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 behavior(s) (if alive), and photo or video of the animal(s) (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 shall 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 (*e.g.,* 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 GoA TMAA 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 December 15 describing the implementation and results (through October of the same year) of the monitoring required in paragraph (c) of this section. The Navy shall 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 15 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 GoA TMAA Report—The Navy shall submit an Annual Exercise GoA TMAA Report on December 15 of every year (covering data gathered through October). This report shall contain the subsections and information indicated below.

(1) MFAS/HFAS Training Exercises—This section shall contain the following information for the following Coordinated and Strike Group Exercises: Joint Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force GoA TMAA:

(i) Exercise Information (for each exercise):

(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 exercise):

(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 (ft);

(I) Visibility;

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

(K) Indication of whether animal is <200 yd, 200–500 yd, 500–1,000 yd, 1,000–2,000 yd, or >2,000 yd from sonar source in (x) above;

(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 (x) is hull-mounted, 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 exercises) 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 other training (*i.e.,* Unit Level Training (ULT)) utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across the GoA TMAA. The Navy shall include (in the GoA TMAA 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 (ft);

(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 (762 m for SINKEX in the GoA TMAA);

(*2*) The required exclusion zone (1 nm for SINKEX in the GoA TMAA);

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

(*4*) Greater than the required observed distance. For example, in this case, the observer shall indicate if <762 m, from 762 m–1 nm, from 1 nm–2 nm, and > 2 nm.

(K) 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.), 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 the GoA TMAA;

(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 shall 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 the GoA TMAA; and

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

(g) GoA TMAA 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 GoA TMAA Exercise Reports and GoA TMAA Monitoring Plan Reports). This report shall be submitted at the end of the fourth year of the rule (December 2014), covering activities that have occurred through October 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 Mariana Islands Range Complex, and the Gulf of Alaska.

(i) The Navy shall comply with the 2009 Integrated Comprehensive Monitoring Program (ICMP) Plan and continue to improve the program in consultation with NMFS. Changes and improvements to the program made during 2010 (as prescribed in the 2009 ICMP and deemed appropriate by the Navy and NMFS) will be described in an updated 2010 ICMP and submitted to NMFS by October 31, 2010, for review. An updated 2010 ICMP will be finalized by December 31, 2010.

### § 218.126 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 § 218.120(c) (*i.e.,* the Navy) must apply for and obtain either an initial Letter of Authorization in accordance with § 218.127 or a renewal under § 218.128.

### § 218.127 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 or biennially subject to renewal conditions in § 218.128.

(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).

**§ 218.128 Renewal of Letters of Authorization and adaptive management.**

(a) A Letter of Authorization issued under § 216.106 and § 218.127 of this chapter or the activity identified in § 218.120(c) shall be renewed annually or biennially upon:

(1) Notification to NMFS that the activity described in the application submitted under § 218.126 shall be undertaken and that there will not be a substantial modification to the described work, mitigation or monitoring undertaken during the upcoming 12–24 months;

(2) Receipt of the monitoring reports and notifications within the indicated timeframes required under § 218.125(b through j); and

(3) A determination by NMFS that the mitigation, monitoring, and reporting measures required under § 218.124 and the Letter of Authorization issued under §§ 216.126 and 218.127 of this chapter were undertaken and will be undertaken during the upcoming period of validity of a renewed Letter of Authorization.

(b) If a request for a renewal of a Letter of Authorization issued under §§ 216.126 and 216.128 indicates that a substantial modification, as determined by NMFS, to the described work, mitigation or monitoring undertaken during the upcoming season will occur, 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 GoA TMAA 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 GoA TMAA 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).

**§ 218.129 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 §§ 216.126 and 218.127 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 § 218.128, 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 § 218.120(b), a Letter of Authorization issued pursuant to §§ 216.126 and 218.127 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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