DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 218

[Docket No. 141125997–6058–01]

RIN 0648–BE67

Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training Activities in the Gulf of Alaska Temporary Maritime Activities Area

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

ACTION: Proposed rule; request for comments and information.

SUMMARY: NMFS has received a request from the U.S. Navy (Navy) for authorization to take marine mammals incidental to the training activities conducted in the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) Study Area (hereafter referred to the Study Area) from May 2016 through May 2021. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue regulations and subsequent Letter of Authorization (LOA) to the Navy to incidentally harass marine mammals.

DATES: Comments and information must be received no later than March 28, 2016.

ADDRESSES: You may submit comments, identified by NOAA–NMFS–2016–0008, by any of the following methods:

- *Electronic submissions:* submit all electronic public comments via the Federal eRulemaking Portal, Go to *www.regulations.gov/#!docketDetail;D=NOAA-NMFS-2016-0008,* click the ''Comment Now!'' icon, complete the required fields, and enter or attach your comments.
- *Mail:* Submit comments to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910–3225.
- *Fax:* (301) 713–0376; Attn: Jolie Harrison.

Instructions: Comments sent by any other method, to any other address or individual, or received after the end of the comment period, may not be considered by NMFS. All comments received are a part of the public record and will generally be posted for public viewing on *www.regulations.gov* without change. All personal identifying information (*e.g.,* name, address, etc.), confidential business information, or otherwise sensitive information submitted voluntarily by the sender will be publicly accessible. 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, or Adobe PDF file formats only.

FOR FURTHER INFORMATION CONTACT: John Fiorentino, Office of Protected Resources, NMFS, (301) 427–8477.

SUPPLEMENTARY INFORMATION:

Availability

A copy of the Navy's LOA application, which contains a list of the references used in this proposed rule, may be obtained by visiting the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm.* The Navy is preparing a Supplemental Environmental Impact Statement (SEIS)/Overseas EIS (OEIS) for the GOA TMAA Study Area to evaluate all components of the proposed training activities. The Navy previously analyzed training activities in the Study Area in the 2011 GOA Navy Training Activities FEIS (GOA FEIS/OEIS) (U.S. Department of the Navy, 2011a). The GOA Draft Supplemental EIS (DSEIS)/OEIS was released to the public on August 23, 2014, for review until October 22, 2014. The Navy is the lead agency for the GOA SEIS/OEIS, and NMFS is a cooperating agency pursuant to 40 CFR 1501.6 and 1508.5. The GOA DSEIS/OEIS, which also contains a list of the references used in this proposed rule, may be viewed at: *http://www.goaeis.com.* Documents cited in this notice may also be viewed, by appointment, during regular business hours, at the aforementioned address.

Background

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

Authorization for incidental takings 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 (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings 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) removed the ''small numbers'' and ''specified geographical region'' limitations indicated above and amended the definition of ''harassment'' as applies to a ''military readiness activity'' to read as follows (section 3(18)(B) of the MMPA, 16 U.S.C. 1362(18)(B)): ''(i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild'' [Level A Harassment]; or ''(ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered'' [Level B Harassment].

Summary of Request

On July 28, 2014, NMFS received an application from the Navy requesting a LOA for the take of 19 species of marine mammals incidental to Navy training activities to be conducted in the Study Area over 5 years. On October 14, 2014, the Navy submitted a revised LOA application to reflect minor changes in the number and types of training activities. To address minor inconsistencies with the DSEIS, the Navy submitted a final revision to the LOA application (hereafter referred to as the LOA application) on January 21, 2015.

The Navy is requesting a 5-year LOA for training activities to be conducted from 2016 through 2021. The Study Area is a polygon roughly the shape of a 300 nm by 150 nm rectangle oriented northwest to southeast in the long direction, located south of Prince William Sound and east of Kodiak Island, Alaska (see Figure 1–1 of the LOA application for a map of the Study Area). The activities conducted within the Study Area are classified as military readiness activities. The Navy states that these activities may expose some of the marine mammals present within the Study Area to sound from underwater acoustic sources and explosives. The Navy requests authorization to take 19 marine mammal species by Level B (behavioral) harassment; one of those marine mammal species (Dall's porpoise) may be taken by Level A (injury) harassment. The Navy is not requesting mortality takes for any species.

The LOA application and the GOA DSEIS/OEIS contain acoustic thresholds that, in some instances, represent changes from what NMFS has used to evaluate the Navy's activities for previous authorizations. The revised thresholds, which the Navy developed in coordination with NMFS, are based on the evaluation and inclusion of new information from recent scientific studies; a detailed explanation of how they were derived is provided in the GOA DSEIS/OEIS Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis Technical Report (available at *http://www.goaeis.com*). The revised thresholds are adopted for this proposed rulemaking.

NOAA is currently in the process of developing Acoustic Guidance on thresholds for onset of auditory impacts from exposure to sound, which will be used to support assessments of the effects of anthropogenic sound on marine mammals. To develop this Guidance, NOAA is compiling, interpreting, and synthesizing the best information currently available on the effects of anthropogenic sound on marine mammals, and is committed to finalizing the Guidance through a systematic, transparent process that involves internal review, external peer review, and public comment.

In December 2013, NOAA released for public comment a ''Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts'' (78 FR 78822) (the term ''threshold shift'' refers to noise-induced hearing loss). The Draft Guidance was generally consistent with the Navy's Permanent Threshold Shifts/Temporary Threshold Shifts (PTS/TTS) criteria used in the GOA DSEIS/OEIS and detailed within Finneran and Jenkins (2012). Prior to the finalization of this guidance by NOAA, the Navy suggested revisions to the criteria (*e.g.,* auditory weighting functions and PTS/TTS thresholds) based on a number of studies available since the Navy's Phase 2 modeling (the acoustic effects modeling currently employed by the Navy for training and testing activities), including Finneran *et al.* (2005), Finneran *et al.* (2010), Finneran and Schlundt (2013), Kastelein *et al.* (2012a), Kastelein *et al.* (2012b), Kastelein *et al.* (2014a), Kastelein *et al.* (2014b), Popov *et al.* (2013), and Popov *et al.* (2011). In January 2015, the Navy submitted a draft proposal (Finneran 2015) to NOAA staff for their consideration.

Finneran (2015) proposed new weighting functions and thresholds for predicting PTS/TTS in marine mammals. The methodologies presented within this paper build upon the methodologies used to develop the criteria applied within the Navy's GOA DSEIS/OEIS (Finneran and Jenkins, 2012) and incorporate relevant auditory research made available since 2012. While Finneran and Jenkins (2012) presented a conservative approach to development of auditory weighting functions where data was limited, Finneran (2015) synthesizes a wide range of auditory data, including newly available studies, to predict refined auditory weighting functions and corresponding TTS thresholds across the complete hearing ranges of functional hearing groups.

During the development process of NOAA's Draft Guidance, NOAA incorporated Finneran (2015) into its Draft Guidance. As a result, the Navy's proposal (Finneran, 2015) was submitted for peer review by external subject matter experts, in accordance with the process previously conducted for NOAA's Draft Guidance. Peer review comments were received by NOAA in April 2015. NOAA subsequently developed a Peer Review Report, which was published on its Web site on July 31, 2015. The published report documents the Navy's proposal (Finneran, 2015) that underwent peer review, the peer-review comments, and NOAA's responses to those comments. NOAA then incorporated this information into revised Draft Guidance which was published in the **Federal Register** for public review and comment (80 FR 45642) on July 31, 2015. The auditory weighting functions and PTS/TTS thresholds provided in that revised Draft Guidance will not be adopted by NOAA or applied to applicants until Final Guidance is issued. At the time of this proposed rulemaking, Final Guidance has not been issued. Therefore, the Navy has not adopted these proposed criteria in its GOA DSEIS/OEIS. However, the underlying science contained within Finneran (2015) has been addressed qualitatively within the applicable sections of the GOA DSEIS/OEIS and this rulemaking.

If the proposed criteria in Finneran (2015) were adopted by NOAA, incorporated into its Final Guidance, and applied to the Navy in the future, predicted numbers of PTS/TTS would change for most functional hearing groups. However, because Finneran (2015) relies on much of the same data as the auditory criteria presented in the Navy's GOA DSEIS/OEIS, these changes would not be substantial, and in most cases would result in a reduction in the predicted impacts. Predicted PTS/TTS would be reduced over much to all of their hearing range for low-frequency cetaceans and phocids. Predicted PTS/TTS for mid-frequency and high-frequency cetaceans would be reduced for sources with frequencies below about 3.5 kHz and remain relatively unchanged for sounds above this frequency. Predicted auditory effects on otariids would increase for frequencies between about 1 kHz and 20 kHz and decrease for frequencies above and below these points, although otariids remain the marine mammals with the least sensitivity to potential PTS/TTS. Overall, predicted auditory effects within this rulemaking would not change significantly.

In summary, NOAA's continuing evaluation of all available science for the Acoustic Guidance could result in changes to the acoustic criteria used to model the Navy's activities for this rulemaking, and, consequently, the enumerations of ''take'' estimates. However, at this time, the results of prior Navy modeling described in this notice represent the best available estimate of the number and type of take that may result from the Navy's use of acoustic sources in the GOA Study Area. Further, consideration of the revised Draft Guidance and information contained in Finneran (2015) does not alter our assessment of the likely responses of marine mammals to acoustic sources employed by Navy in the GOA Study Area, or the likely fitness consequences of those responses. Finally, while acoustic criteria may also inform mitigation and monitoring decisions, this rulemaking requires a robust adaptive management program that regularly addresses new information and allows for modification of mitigation and/or monitoring measures as appropriate.

Background of Request

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by federal law (10 U.S.C. 5062), which ensures the readiness of the naval forces of the United States.[1] The Navy executes this responsibility by establishing and executing training programs, including at-sea training and exercises, and ensuring naval forces have access to the ranges, operating areas (OPAREAs), and airspace needed to develop and maintain skills for conducting naval activities.

The Navy proposes to continue conducting training activities within the Study Area, which have been ongoing since the 1990s. The tempo and types of training activities have fluctuated because of the introduction of new technologies, the evolving nature of international events, advances in war fighting doctrine and procedures, and force structure (organization of ships, submarines, aircraft, weapons, and personnel) changes. Such developments influence the frequency, duration, intensity, and location of required training activities.

The Navy's LOA request covers training activities that would occur for a 5-year period following the expiration of the current MMPA authorization for the GOA TMAA, which expires in 2016.

Description of the Specified Activity

The Navy is requesting authorization to take marine mammals incidental to conducting training activities. The Navy has determined that sonar use and underwater detonations are the stressors most likely to result in impacts on marine mammals that could rise to the level of harassment. Detailed descriptions of these activities are provided in the DSEIS/OEIS and in the LOA application (*http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm*) and are summarized here.

Overview of Training Activities

The Navy routinely trains in the Study Area in preparation for national defense missions. Training activities and exercises covered in the Navy's LOA request are briefly described below, and in more detail within chapter 2 of the GOA DSEIS/OEIS. Each military training activity described meets a requirement that can be traced ultimately to requirements set forth by the National Command Authority.[2]

The Navy categorizes training activities into eight functional warfare areas called primary mission areas: anti-air warfare; amphibious warfare; strike warfare; anti-surface warfare (ASUW); anti-submarine warfare (ASW); electronic warfare; mine warfare (MIW); and naval special warfare (NSW). Most training activities are categorized under one of these primary mission areas; those activities that do not fall within one of these areas are in a separate ''other'' category. Each warfare community (surface, subsurface, aviation, and special warfare) may train within some or all of these primary mission areas. However, not all primary mission areas are conducted within the Study Area.

The Navy described and analyzed the effects of its training activities within the GOA DSEIS/OEIS. In its assessment, the Navy concluded that of the activities conducted within the Study Area, sonar use and underwater detonations were the stressors resulting in impacts on marine mammals that could rise to the level of harassment as defined under the MMPA. Therefore, the LOA application provides the Navy's assessment of potential effects from these stressors. The specific acoustic sources used in the LOA application are contained in the GOA DSEIS/OEIS and are presented in the following sections based on the primary mission areas.

Anti-Surface Warfare (ASUW)

The mission of ASUW is to defend against enemy ships or boats. In the conduct of ASUW, aircraft use cannons, air-launched cruise missiles or other precision-guided munitions; ships employ torpedoes, naval guns, and surface-to-surface (S–S) missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles.

Anti-surface warfare training in the Study Area includes S–S gunnery and missile exercises (GUNEX and MISSILEX) and air-to-surface (A–S) bombing exercises (BOMBEX), GUNEX, and MISSILEX. Also included in this mission area is a sinking exercise that may include S–S and A–S components.

Anti-Submarine Warfare (ASW)

The mission of ASW is to locate, neutralize, and defeat hostile submarine threats to surface forces. ASW is based on the principle of a layered defense of surveillance and attack aircraft, ships, and submarines all searching for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack hostile submarine threats.

Anti-submarine warfare training addresses basic skills such as detection and classification of submarines, distinguishing between sounds made by enemy submarines and those of friendly submarines, ships, and marine life. ASW training evaluates the ability of fleet assets to use systems, for example, active and passive sonar and torpedo systems to counter hostile submarine threats. More advanced, integrated ASW training exercises are conducted in coordinated, at-sea training events involving submarines, ships, and aircraft. This training integrates the full spectrum of ASW from detecting and tracking a submarine to attacking a target using simulated weapons.

Description of Sonar, Ordnance, Targets, and Other Systems

The Navy uses a variety of sensors, platforms, weapons, and other devices to meet its mission. Training with these systems and devices may introduce acoustic (sound) energy into the environment. The Navy's current LOA application describes underwater sound as one of two types: impulsive and non-impulsive. Sonar and similar sound producing systems are categorized as non-impulsive sound sources. Underwater detonations of explosives and other percussive events are impulsive sounds.

Sonar and Other Active Acoustic Sources

Modern sonar technology includes a variety of sonar sensor and processing systems. In concept, the simplest active sonar emits sound waves, or ''pings,'' sent out in multiple directions, and the sound waves then reflect off of the target object in multiple directions. The sonar source calculates the time it takes for the reflected sound waves to return; this calculation determines the distance to the target object. More sophisticated active sonar systems emit a ping and then rapidly scan or listen to the sound waves in a specific area. This provides both distance to the target and directional information. Even more advanced sonar systems use multiple receivers to listen to echoes from several directions simultaneously and provide efficient detection of both direction and distance. Active sonar is rarely used continuously throughout the listed activities. In general, when sonar is in use, the sonar 'pings' occur at intervals, referred to as a duty cycle, and the signals themselves are very short in duration. For example, sonar that emits a 1-second ping every 10 seconds has a 10 percent duty cycle. The Navy's largest hull-mounted mid-frequency sonar source typically emits a 1-second ping every 50 seconds representing a 2 percent duty cycle. The Navy utilizes sonar systems and other acoustic sensors in support of a variety of

[1] Title 10, Section 5062 of the U.S.C.

[2] ''National Command Authority'' is a term used by the United States military and government to refer to the ultimate lawful source of military orders. The term refers collectively to the President of the United States (as commander-in-chief) and the United States Secretary of Defense.

mission requirements. Primary uses include the detection of and defense against submarines (ASW) and mines (MIW); safe navigation and effective communications; use of unmanned undersea vehicles; and oceanographic surveys. Sources of sonar and other active acoustic sources include surface ship sonar, sonobuoys, torpedoes, and unmanned underwater vehicles.

Ordnance and Munitions

Most ordnance and munitions used during training events fall into three basic categories: Projectiles (such as gun rounds), missiles (including rockets), and bombs. Ordnance can be further defined by their net explosive weight (NEW), which considers the type and quantity of the explosive substance without the packaging, casings, bullets, etc. NEW is the trinitrotoluene (TNT) equivalent of energetic material, which is the standard measure of strength of bombs and other explosives. For example, a 5-inch shell fired from a Navy gun is analyzed at approximately 9.5 pounds (lb.) (4.3 kilograms [kg]) of NEW. The Navy also uses non-explosive ordnance in place of explosive ordnance in many training and testing events. Non-explosive ordnance look and perform similarly to explosive ordnance, but lack the main explosive charge.

Defense Countermeasures

Naval forces depend on effective defensive countermeasures to protect themselves against missile and torpedo attack. Defensive countermeasures are devices designed to confuse, distract, and confound precision-guided munitions. Defensive countermeasures analyzed in this LOA application include acoustic countermeasures, which are used by surface ships and submarines to defend against torpedo attack. Acoustic countermeasures are either released from ships and submarines, or towed at a distance behind the ship.

Classification of Non-Impulsive and Impulsive Sources Analyzed

In order to better organize and facilitate the analysis of approximately 300 individual sources of underwater acoustic sound or explosive energy, a series of source classifications, or source bins, were developed by the Navy. The use of source classification bins provides the following benefits:

• Provides the ability for new sensors or munitions to be covered under existing regulatory authorizations, as long as those sources fall within the parameters of a ''bin'';

• Simplifies the source utilization data collection and reporting requirements anticipated under the MMPA;

• Ensures a conservative approach to all impact analysis, as all sources in a single bin are modeled as the loudest source (*e.g.,* lowest frequency, highest source level [the term ''source level'' refers to the loudness of a sound at its source], longest duty cycle, or largest net explosive weight [NEW]) within that bin, which:

○ Allows analysis to be conducted more efficiently, without compromising the results; and

○ Provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total number and severity of marine mammal takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training requirements, which are linked to real world events.

There are two primary types of acoustic sources: Impulsive and non-impulsive. A description of each source classification is provided in Tables 1 and 2. Impulsive source class bins are based on the NEW of the munitions or explosive devices or the source level for air and water guns. Non-impulsive acoustic sources are grouped into source class bins based on the frequency,[3] source level,[4] and, when warranted, the application in which the source would be used. The following factors further describe the considerations associated with the development of non-impulsive source bins:

• Frequency of the non-impulsive source.
  ○ Low-frequency sources operate below 1 kilohertz (kHz)
  ○ Mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz
  ○ High-frequency sources operate above 10 kHz, up to and including 100 kHz
  ○ Very high-frequency sources operate above 100 kHz but below 200 kHz
• Source level of the non-impulsive source.
  ○ Greater than 160 decibels (dB), but less than 180 dB
  ○ Equal to 180 dB and up to 200 dB
  ○ Greater than 200 dB
• Application in which the source would be used.

○ How a sensor is employed supports how the sensor's acoustic emissions are analyzed.

○ Factors considered include pulse length (time source is on); beam pattern (whether sound is emitted as a narrow, focused beam or, as with most explosives, in all directions); and duty cycle (how often or how many times a transmission occurs in a given time period during an event).

As described in the GOA DSEIS/OEIS, non-impulsive acoustic sources that have low source levels (not loud), narrow beam widths, downward directed transmission, short pulse lengths, frequencies beyond known hearing ranges of marine mammals, or some combination of these characteristics, are not anticipated to result in takes of protected species and therefore were not modeled. These sources generally meet the following criteria and are qualitatively analyzed in the GOA DSEIS/OEIS:

• Acoustic sources with frequencies greater than 200 kHz (based on known marine mammal hearing ranges)
• Sources with source levels less than 160 dB

TABLE 1—IMPULSIVE (EXPLOSIVE) TRAINING SOURCE CLASSES ANALYZED

Source class	Representative munitions	Net explosive weight (lbs)
E5	5-inch projectiles	>5–10
E6	AGM–114 Hellfire missile	>10–20
E7	AGM–88 High-speed Anti-Radiation Missile	>20–60
E8	250 lb. bomb	>60–100
E9	500 lb. bomb	>100–250

[3] Bins are based on the typical center frequency of the source. Although harmonics may be present, those harmonics would be several decibels (dB) lower than the primary frequency.

[4] Source decibel levels are expressed in terms of sound pressure level (SPL) and are values given in dB referenced to 1 micropascal at 1 meter.

TABLE 1—IMPULSIVE (EXPLOSIVE) TRAINING SOURCE CLASSES ANALYZED—Continued

Source class	Representative munitions	Net explosive weight (lbs)
E10	1,000 lb. bomb/Air-to-surface missile	>250–500
E11	MK–48 torpedo	>500–650
E12	2,000 lb. bomb	>650–1,000

TABLE 2—NON-IMPULSIVE TRAINING SOURCE CLASSES ANALYZED.

Source class category	Source class	Description of representative sources
Mid-Frequency (MF): Tactical and non-tactical sources that produce mid-frequency (1–10 kHz) signals.	MF1	Hull-mounted surface ship sonar (*e.g.*, AN/SQS–53C and AN/SQS–60).
	MF3	Hull-mounted submarine sonar (*e.g.*, AN/BQQ–10).
	MF4	Helicopter-deployed dipping sonar (*e.g.*, AN/AQS–22 and AN/AQS–13).
	MF5	Active acoustic sonobuoys (*e.g.*, DICASS).
	MF6	Active underwater sound signal devices (*e.g.*, MK–84).
	MF11	Hull-mounted surface ship sonar with an active duty cycle greater than 80%.
High-Frequency (HF): Tactical and non-tactical sources that produce high-frequency (greater than 10 kHz but less than 100 kHz) signals.	HF1	Hull-mounted submarine sonar (*e.g.*, AN/BQQ–10).
	HF6	Active sources (equal to 180 dB and up to 200 dB).
Anti-Submarine Warfare (ASW): Tactical sources such as active sonobuoys and acoustic countermeasures systems used during the conduct of ASW training activities.	ASW2	
	ASW3	Mid-frequency Multistatic Active Coherent sonobuoy (*e.g.*, AN/SSQ–125).
		Mid-frequency towed active acoustic countermeasure systems (*e.g.*, AN/SLQ–25).
	ASW4	Mid-frequency expendable active acoustic device countermeasures (*e.g.*, MK–3).
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes.	TORP2	Heavyweight torpedo (*e.g.*, MK–48, electric vehicles).

Notes: dB = decibels, DICASS = Directional Command Activated Sonobuoy System, kHz = kilohertz

Training

The training activities that the Navy proposes to conduct in the Study Area are described in Table 3. The table is organized according to primary mission areas and includes the activity name, associated stressor(s), description of the activity, the primary platform used (*e.g.,* ship or aircraft type), duration of activity, type of non-impulsive or impulsive sources used in the activity, and the number of activities per year. More detailed activity descriptions can be found in chapter 2 of the GOA DSEIS/OEIS. The Navy's Proposed Activities are anticipated to meet training needs in the years 2016–2021.

TABLE 3—TRAINING ACTIVITIES WITHIN THE STUDY AREA

Category	Training activity	Description	Weapons/rounds/sound source
Anti-Surface Warfare (ASUW)			
Impulsive	Gunnery Exercise, Surface-to-Surface (Ship) (GUNEX–S–S [Ship]).	Ship crews engage surface targets with ship's small-, medium-, and large-caliber guns. Some of the small- and medium-caliber gunnery exercises analyzed include those conducted by the U.S. Coast Guard.	Small-, Medium-, and Large-caliber high explosive rounds.
Impulsive	Sinking Exercise	Fixed-wing aircrews, surface ships and submarine firing precision-guided and non-precision weapons against a surface target.	High explosive bombs, missiles, Large-caliber rounds and torpedoes.
Impulsive	Bombing Exercise (Air-to-Surface) (BOMBEX [A–S]).	Fixed-wing aircrews deliver bombs against surface targets.	High explosive bombs.
Anti-Submarine Warfare (ASW)			
Non-impulsive	Tracking Exercise—Submarine (TRACKEX—Sub).	Submarine searches for, detects, and tracks submarine(s) and surface ship(s).	Mid- and high-frequency submarine sonar.

TABLE 3—TRAINING ACTIVITIES WITHIN THE STUDY AREA—Continued

Category	Training activity	Description	Weapons/rounds/sound source
Non-impulsive	Tracking Exercise—Surface (TRACKEX—Surface).	Surface ship searches for, tracks, and detects submarine(s).	Mid-frequency surface ship sonar, acoustic countermeasures, and high-frequency active sources.
Non-impulsive	Tracking Exercise—Helicopter (TRACKEX—Helo).	Helicopter searches, tracks, and detects submarine(s)	Mid-frequency dipping sonar systems and sonobuoys.
Non-impulsive	Tracking Exercise—Maritime Patrol Aircraft (TRACKEX—MPA).	Maritime patrol aircraft use sonobuoys to search for, detect, and track submarine(s).	Sonobuoys, such as DICASS sonobuoys.
Non-impulsive	Tracking Exercise—Maritime Patrol Aircraft (MAC Sonobuoys).	Maritime patrol aircraft crews search for, detect and track submarines using MAC sonobuoys.	mid-frequency MAC sonobuoys.

Notes: DICASS = Directional Command Activated Sonobuoy System; MAC=Multistatic Active Coherent

Summary of Impulsive and Non-Impulsive Sources

Table 4 provides a quantitative annual summary of training activities by sonar and other active acoustic source class analyzed in the Navy's LOA request.

TABLE 4—ANNUAL HOURS OF SONAR AND OTHER ACTIVE ACOUSTIC SOURCES USED DURING TRAINING WITHIN THE STUDY AREA

Source class category	Source class	Units	Annual use
Mid-Frequency (MF) Active sources from 1 to 10 kHz	MF1	Hours	541
	MF3	Hours	48
	MF4	Hours	53
	MF5	Items	25
	MF6	Items	21
	MF11	Hours	78
High-Frequency (HF): Tactical and non-tactical sources that produce signals greater than 10 kHz but less than 100 kHz.	HF1	Hours	24
	HF6	Hours	80
Anti-Submarine Warfare (ASW) Active ASW sources	ASW2	Hours	80
	ASW3	Hours	546
	ASW4	Items	4
Torpedoes (TORP) Source classes associated with active acoustic signals produced by torpedoes.	TORP2	Items	5

Table 5 provides a quantitative annual summary of training explosive source classes analyzed in the Navy's LOA request.

TABLE 5—ANNUAL NUMBER OF TRAINING EXPLOSIVE SOURCE DETONATIONS USED DURING TRAINING WITHIN THE STUDY AREA

Explosive class net explosive weight (pounds [lb.])	Annual in-water detonations training
E5 (> 5–10 lb.)	112
E6 (> 10–20 lb.)	2
E7 (> 20–60 lb.)	4
E8 (> 60–100 lb.)	6
E9 (> 100–250 lb.)	142
E10 (> 250–500 lb.)	32
E11 (> 500–650 lb.)	2
E12 (> 650–1,000 lb.)	4

Duration and Location

Training activities would be conducted in the Study Area during two exercises of up to 21 days each per year (for a total of up to 42 days per year) to support a major joint training exercise in Alaska and off the Alaskan coast that involves the Departments of the Navy, the Army and the Air Force, and the U.S. Coast Guard (Coast Guard). The Service participants report 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. The exercises would occur between the months of May and October of each year from 2016 to 2021.

The Study Area (see Figure 1–1 of the LOA application) is entirely at sea and is composed of the established GOA TMAA and a warning area in the Gulf of Alaska. The Navy uses ''at-sea'' to include its training activities in the Study Area that occur (1) on the ocean surface, (2) beneath the ocean surface, and (3) in the air above the ocean surface. Navy training activities occurring on or over the land outside the GOA TMAA are covered under previously prepared environmental documentation prepared by the U.S. Air Force and the U.S. Army.

Gulf of Alaska Temporary Maritime Activities Area (GOA TMAA)

The GOA TMAA is a temporary area established in conjunction with the Federal Aviation Administration (FAA) for up to two exercise periods of up to 21 days each, for a total of 42 days per year, that is a surface, undersea space, and airspace maneuver area within the Gulf of Alaska for ships, submarines, and aircraft to conduct required training activities. The GOA TMAA is a polygon roughly resembling a rectangle oriented from northwest to southeast, approximately 300 nautical miles (nm) in length by 150 nm in width, located south of Prince William Sound and east of Kodiak Island.

Airspace of the GOA TMAA

The airspace of the GOA TMAA overlies the surface and subsurface training area and is called an Altitude Reservation (ALTRV). This ALTRV is a temporary airspace designation, typically requested by the Alaskan Command (ALCOM) and coordinated through the FAA for the duration of the exercise. This overwater airspace supports the majority of aircraft training activities conducted by Navy and Joint aircraft throughout the joint training exercise. The ALTRV over the GOA TMAA typically extends from the ocean surface to 60,000 feet (ft.) (18,288 meters [m]) above mean sea level and encompasses 42,146 square nautical miles (nm^2) of airspace. For safety considerations, ALTRV information is sent via Notice to Airmen (NOTAM)/ International NOTAM so that all pilots are aware of the area and that Air Traffic Control will keep known Instrument Flight Rules aircraft clear of the area.

Additionally, the GOA TMAA overlies a majority of Warning Area W–612 (W–612) located over Blying Sound, towards the northwestern quadrant of the GOA TMAA. When not included as part of the GOA TMAA, W–612 provides 2,256 nm^2 of special use airspace for the Air Force and Coast Guard to fulfill some of their training requirements. Air Force, Army, National Guard, and Coast Guard activities conducted as part of at-sea joint training within the GOA TMAA are included in the DSEIS/OEIS analysis. No Navy training activities analyzed in this proposed rule occur in the area of W–612 that is outside of the GOA TMAA (see Figure 1–1 of the LOA application).

Sea and Undersea Space of the GOA TMAA

The GOA TMAA surface and subsurface areas are also depicted in Figure 1–1 of the LOA application. Total surface area of the GOA TMAA is 42,146 nm^2. Due to weather conditions, annual joint training activities are typically conducted during the summer months (April–October). The GOA TMAA undersea area lies beneath the surface area as depicted in Figure 1–1 of the LOA application. The undersea area extends to the seafloor.

The complex bathymetric and oceanographic conditions, including a continental shelf, submarine canyons, numerous seamounts, and fresh water infusions from multiple sources, create a challenging environment in which to search for and detect submarines in ASW training activities. In the summer, the GOA TMAA provides a safe cold-water training environment that resembles other areas where Navy may need to operate in a real-world scenario.

The GOA TMAA meets large-scale joint exercise training objectives to support naval and joint operational readiness by providing a ''geographically realistic'' training area for U.S. Pacific Command, Joint Task Force Commander scenario-based training, and supports the mission requirement of Alaskan Command (ALCOM) to conduct joint training for Alaska-based forces. The strategic vision of the Commander, U.S. Pacific Fleet is that the training area support naval operational readiness by providing a realistic, live-training environment for forces assigned to the Pacific Fleet and other users with the capability and capacity to support current, emerging, and future training requirements.

Description of Marine Mammals in the Area of the Specified Activities

Marine mammal species known to occur in the Study Area and their currently recognized stocks are presented in Table 6 consistent with the NMFS' U.S. Pacific Marine Mammal Stock Assessment Report (Carretta *et al.,* 2015) and the Alaska Marine Mammal Stock Assessment Report (Muto and Angliss, 2015). Twenty-two marine mammal species have confirmed or possible occurrence within or adjacent to the Study Area, including seven species of baleen whales (mysticetes), eight species of toothed whales (odontocetes), six species of seals (pinnipeds), and the sea otter (mustelid). Nine of these species are listed under the ESA: Blue whale, fin whale, humpback whale, sei whale, sperm whale, gray whale (Western North Pacific stock), North Pacific right whale, Steller sea lion (Western U.S. stock), and sea otter. All these species are managed by NMFS or the U.S. Fish and Wildlife Service (USFWS) in the U.S. Exclusive Economic Zone (EEZ).

The species carried forward for analysis are those likely to be found in the Study Area based on the most recent data available, and do not include stocks or species that may have once inhabited or transited the area but have not been sighted in recent years (*e.g.,* species which were extirpated because of factors such as nineteenth and twentieth century commercial exploitation). Several species that may be present in the Gulf of Alaska have an extremely low probability of presence in the Study Area. These species are considered extralimital, meaning there may be a small number of sighting or stranding records within the Study Area, but the area of concern is outside the species' range of normal occurrence. These species include beluga whale (*Delphinapterus leucas*), false killer whale (*Pseudorca crassidens*), short-finned pilot whale (*Globicephala macrorhynchus*), northern right whale dolphin (*Lissodelphis borealis*), and Risso's dolphin (*Grampus griseus*), and have been excluded from subsequent analysis.

TABLE 6—MARINE MAMMALS WITH POSSIBLE OR CONFIRMED PRESENCE WITHIN THE STUDY AREA

Common name	Scientific name [1]	Stock [2]	Stock abundance [3] (CV)	Occurrence in region [4]	ESA/MMPA Status
Order Cetacea Suborder Mysticeti (baleen whales) Family Balaenidae (right whales)					
North Pacific right whale.	*Eubalaena japonica*	Eastern North Pacific	31 (0.23)	Rare	Endangered/Depleted.
Family Balaenopteridae (rorquals)					
Humpback whale	*Megaptera novaeangliae.*	Central North Pacific	10,252 (0.042)	Likely	Endangered/D Depleted.
		Western North Pacific	893 (0.079)	Likely	Endangered/D Depleted.

TABLE 6—MARINE MAMMALS WITH POSSIBLE OR CONFIRMED PRESENCE WITHIN THE STUDY AREA—Continued

Common name	Scientific name [1]	Stock [2]	Stock abundance [3] (CV)	Occurrence in region [4]	ESA/MMPA Status
Blue whale	*Balaenoptera musculus*.	Eastern North Pacific	1,647 (0.07)	Seasonal; highest likelihood July to December.	Endangered/D Depleted.
		Central North Pacific	81 (1.14)	Seasonal; highest likelihood July to December.	Endangered/D Depleted.
Fin whale	*Balaenoptera physalus*.	Northeast Pacific	1,368 (minimum estimate) (n/a).	Likely	Endangered/D Depleted.
Sei whale	*Balaenoptera borealis*	Eastern North Pacific	126 (0.53)	Rare	Endangered/D Depleted.
Minke whale	*Balaenoptera acutorostrata*.	Alaska	Not available	Likely.	
Family Eschrichtiidae (gray whale)					
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	20,990 (0.05)	Likely: Highest numbers during seasonal migrations.	
		Western North Pacific	140 (0.043)	Rare: Individuals migrate through GOA.	Endangered/D Depleted.
Suborder Odontoceti (toothed whales) Family Physeteridae (sperm whale)					
Sperm whale	*Physeter macrocephalus*.	North Pacific	Not available	Likely; More likely in waters > 1,000 m depth, most often > 2,000 m.	Endangered/D Depleted.
Family Delphinidae (dolphins)					
Killer whale	*Orcinus orca*	Alaska Resident	2,347 (n/a)	Likely.	
		Eastern North Pacific Offshore.	211: includes known offshore killer whales along the U.S. west coast, Canada, and Alaska (n/a).	Infrequent: few sightings.	
		AT1 Transient	7	Rare; more likely inside Prince William Sound and Kenai Fjords.	
		GOA, Aleutian Island, and Bering Sea Transient.	587	Likely.	
Pacific white-sided dolphin.	*Lagenorhynchus obliquidens*.	North Pacific	26,880; specific to the GOA, not the management stock (n/a).	Likely.	
Family Phocoenidae (porpoises)					
Harbor porpoise	*Phocoena phocoena*	GOA	31,046 (0.21)	Likely in nearshore locations.	
		Southeast Alaska	11,146 (0.24)	Likely in nearshore locations.	
Dall's porpoise	*Phocoenoides dalli*	Alaska	83,400 (0.097); based on survey data from 1987–1991.	Likely.	
Family Ziphiidae (beaked whales)					
Cuvier's beaked whale	*Ziphius cavirostris*	Alaska	Not available	Likely.	
Baird's beaked whale	*Berardius bairdii*	Alaska	Not available	Likely.	
Stejneger's beaked whale.	*Mesoplodon stejnegeri*.	Alaska	Not available	Likely.	

TABLE 6—MARINE MAMMALS WITH POSSIBLE OR CONFIRMED PRESENCE WITHIN THE STUDY AREA—Continued

Common name	Scientific name [1]	Stock [2]	Stock abundance [3] (CV)	Occurrence in region [4]	ESA/MMPA Status
Order Carnivora **Suborder Pinnipedia [5]** **Family Otariidae (fur seals and sea lions)**					
Steller sea lion	*Eumetopias jubatus*	Eastern U.S.	59,968 (minimum estimate) (n/a).	Likely.	
		Western U.S.	49,497 (minimum estimate) (n/a).	Likely	Endangered/D Depleted.
California sea lion	*Zalophus californianus*.	U.S.	296,750 (n/a)	Rare.	
Northern fur seal	*Callorhinus ursinus*	Eastern Pacific	648,534 (n/a)	Likely	Depleted.
Family Phocidae (true seals)					
Northern elephant seal	*Mirounga angustirostris*.	California Breeding	179,000 (n/a)	Likely.	
Harbor seal	*Phoca vitulina*	Aleutian Islands	6,431 (n/a)	Extralimital	
		Pribilof Islands	232 (n/a)	Extralimital.	
		Bristol Bay	32,350 (n/a)	Extralimital.	
		N. Kodiak	8,321 (n/a)	Rare (inshore waters).	
		S. Kodiak	19,199 (n/a)	Rare (inshore waters).	
		Prince William Sound	29,889 (n/a)	Rare (inshore waters).	
		Cook Inlet/Shelikof	27,386 (n/a)	Extralimital.	
		Glacier Bay/Icy Strait	7,210 (n/a)	Rare (inshore waters).	
		Lynn Canal/S Stephens.	9,478 (n/a)	Extralimital.	
		Sitka/Chatham	14,855 (n/a)	Rare (inshore waters).	
		Dixon/Cape Decision	18,105 (n/a)	Rare (inshore waters).	
		Clarence Strait	31,634 (n/a)	Extralimital.	
Ribbon seal	*Histriophoca fasciata*	Alaska	184,000	Rare.	
Family Mustelidae (otters) [6]					
Northern sea otter	*Enhydra lutris kenyoni*.	Southeast Alaska	10,563	Rare.	
		Southcentral Alaska	15,090	Rare.	
		Southwest Alaska	47,676	Rare	Threatened.

[1] Taxonomy follows Perrin *et al.* (2009).

[2] Stock names and abundance estimates from Muto and Angliss (2015) and Carretta *et al.* (2015) except where noted.

[3] The stated coefficient of variation (CV) from the NMFS Stock Assessement Reports is an indicator of uncertainty in the abundance estimate and describes the amount of variation with respect to the population mean. It is expressed as a fraction or sometimes a percentage and can range upward from zero, indicating no uncertainty, to high values. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. When the CV exceeds 1.0, the estimate is very uncertain. The uncertainty associated with movements of animals into or out of an area (due to factors such as availability of prey or changing oceanographic conditions) is much larger than is indicated by the CVs that are given.

[4] EXTRALIMITAL: There may be a small number of sighting or stranding records, but the area is outside the species range of normal occurrence. RARE: The distribution of the species is near enough to the area that the species could occur there, or there are a few confirmed sightings. INFREQUENT: Confirmed, but irregular sightings or acoustic detections. LIKELY: Confirmed and regular sightings or acoustic detections of the species in the area year-round. SEASONAL: Confirmed and regular sightings or acoustic detections of the species in the area on a seasonal basis.

[5] There are no data regarding the CV for some of the pinniped species given that abundance is determined by different methods than those used for cetaceans.

[6] There are no data regarding the CV for sea otter given that abundance is determined by different methods than those used for cetaceans.

Notes: CV = coefficient of variation, ESA = Endangered Species Act, GOA = Gulf of Alaska, m = meter(s), MMPA = Marine Mammal Protection Act, n/a = not available, U.S. = United States.

Information on the status, distribution, abundance, and vocalizations of marine mammal species in the Study Area may be viewed in Chapter 4 of the LOA application (*http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm*). Additional information on the general biology and ecology of marine mammals are included in the GOA DSEIS/OEIS. In addition, NMFS annually publishes Stock Assessment Reports (SARs) for all marine mammals in U.S. EEZ waters, including stocks that occur within the Study Area (U.S. Pacific Marine Mammal Stock Assessments, Carretta *et al.,* 2015; Alaska Marine Mammal Stock Assessments, Muto and Angliss, 2015).

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).

Marine mammal vocalizations often extend both above and below the range of human hearing; vocalizations with frequencies lower than 20 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 baleen whales 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 microPascal (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).

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 proposed rule. A summary is included below.

Sound is a wave of pressure variations propagating through a medium (*e.g.,* 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 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 acoustic power (and a 20-dB increase is then a 100-fold increase in power; and a 30-dB increase is a 1,000-fold increase in power). A ten-fold increase in acoustic power does not mean that the sound is perceived as being ten times louder, however. Humans perceive a 10-dB increase in sound level as a doubling of loudness, and a 10-dB decrease in sound level 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 proposed rule, NMFS uses 1 μPa (denoted re: 1μPa) as a standard reference pressure unless noted otherwise.

It is important to note that decibel values underwater and decibel values in air are not the same (different reference pressures and densities/sound speeds between media) and should not 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 level in air and in water would be approximately 62 dB lower in air. Thus, a sound that measures 160 dB (re 1 μPa) underwater would have the same approximate effective level as a sound that is 98 dB (re 20 μPa) 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. Current data indicate that not all marine mammal species have equal hearing capabilities (Richardson *et al.,* 1995; Southall *et al.,* 1997; Wartzok and Ketten, 1999; Au and Hastings, 2008).

Southall *et al.* (2007) designated ''functional hearing groups'' for marine mammals based on available behavioral data; audiograms derived from auditory evoked potentials; anatomical modeling; and other data. Southall *et al.* (2007) also estimated the lower and upper frequencies of functional hearing for each group. However, animals are less sensitive to sounds at the outer edges of their functional hearing range and are more sensitive to a range of frequencies within the middle of their functional hearing range. Note that direct measurements of hearing sensitivity do not exist for all species of marine mammals, including low-frequency cetaceans. The functional hearing groups and the associated frequencies developed by Southall *et al.* (2007) were revised by Finneran and Jenkins (2012) and have been further modified by NOAA. Table 7 provides a summary of sound production and general hearing capabilities for marine mammal species (note that values in this table are not meant to reflect absolute possible maximum ranges, rather they represent the best known ranges of each functional hearing group). For purposes of the analysis in this proposed rule, marine mammals are arranged into the following functional hearing groups based on their generalized hearing sensitivities: High-frequency cetaceans, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), phocids (true seals), otariids (sea lion and fur seals), and mustelids (sea otters). A detailed discussion of the functional hearing groups can be found in Southall et al. (2007) and Finneran and Jenkins (2012).

TABLE 7—MARINE MAMMAL FUNCTIONAL HEARING GROUPS

Functional hearing group	Functional hearing range *
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 25 kHz.
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.
High-frequency (HF) cetaceans (true porpoises, *Kogia,* river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*).	200 Hz to 180 kHz.
Phocid pinnipeds (underwater) (true seals)	75 Hz to 100 kHz.
Otariid pinnipeds (underwater) (sea lions and fur seals)	100 Hz to 48 kHz.

Adapted and derived from Southall *et al.* (2007)

* Represents frequency band of hearing for entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Functional hearing is defined as the range of frequencies a group hears without incorporating non-acoustic mechanisms (Wartzok and Ketten, 1999). This is ~60 to ~70 dB above best hearing sensitivity (Southall *et al.,* 2007) for all functional hearing groups except LF cetaceans, where no direct measurements on hearing are available. For LF cetaceans, the lower range is based on recommendations from Southall *et al.,* 2007 and the upper range is based on information on inner ear anatomy and vocalizations.

When sound travels (propagates) 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 away. Acousticians often refer to the loudness of a sound at its source (typically referenced to one meter from the source) as the source level and the loudness of sound elsewhere as the received level (*i.e.,* typically the receiver). For example, a humpback whale 3 km from a device that has a source level of 230 dB may only be exposed to sound that is 160 dB loud, depending on how the sound travels through water (*e.g.,* spherical spreading [3 dB reduction with doubling of distance] was used in this example). As a result, it is important to understand the difference between 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 active sonar operations, crews will measure oceanic conditions, such as sea water temperature and depth, to calibrate models that determine the path the sonar signal will take as it travels through the ocean and how strong the sound signal will be at a given range along a particular transmission path). As sound travels through the ocean, the intensity associated with the wavefront diminishes, or attenuates. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss.

Metrics Used in This Proposed Rule

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

Sound pressure level (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.

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

The commonly used reference pressure level in underwater acoustics is 1 μPa, and the units for SPLs are dB re: 1 μPa. SPL is an instantaneous pressure measurement and can be expressed as the peak, the peak-peak, or the root mean square (rms). Root mean square pressure, 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 proposed rule refer to the root mean square. SPL does not take the duration of exposure 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).

Sound exposure level (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 μPa^2-s. Below is a simplified formula for SEL.

SEL = SPL + 10log (duration in seconds)

As applied to active sonar, the SEL includes both the SPL of a sonar ping and the total duration. Longer duration pings and/or pings with higher SPLs will have a higher SEL. If an animal is exposed to multiple pings, the SEL in each individual ping is summed to calculate the cumulative SEL. The cumulative 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 as cumulative 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 Study Area. The Navy has analyzed potential impacts to marine mammals from impulsive and non-impulsive sound sources.

Other potential impacts to marine mammals from training activities in the Study Area were analyzed in the GOA DSEIS/OEIS, in consultation with NMFS as a cooperating agency, and determined to be unlikely to result in marine mammal harassment. Therefore, the Navy has not requested authorization for take of marine mammals that might occur incidental to other components of their proposed activities. In this proposed rule, NMFS analyzes the potential effects on marine mammals from exposure to non-impulsive sound sources (sonar and other active acoustic sources) and impulsive sound sources (underwater detonations).

For the purpose of MMPA authorizations, NMFS' effects assessments serve four primary purposes: (1) To prescribe the permissible methods of taking (*i.e.,* Level B harassment (behavioral harassment), Level A harassment (injury), or mortality, including an identification of the number and types of take that could occur by harassment or mortality) and to prescribe other means of effecting the least practicable adverse impact on such species or stock and its habitat (*i.e.,* mitigation); (2) to determine whether the specified activity would have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activity would adversely affect the species or stock through effects on annual rates of recruitment or survival); (3) to determine whether the specified activity would have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses; and (4) to prescribe requirements pertaining to monitoring and reporting.

This section focuses qualitatively on the different ways that non-impulsive and impulsive sources may affect marine mammals (some of which NMFS would not classify as harassment). Then the Estimated Take of Marine Mammals section discusses how the potential effects of non-impulsive and impulsive sources on marine mammals will be related to the MMPA definitions of Level A and Level B Harassment, and attempts to quantify those effects.

Non-impulsive Sources

Direct Physiological Effects

Based on the literature, there are two basic ways that non-impulsive sources 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 detect them) following exposure to an intense sound or sound for long duration, 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 complete recovery), can occur in specific frequency ranges (*i.e.,* an animal might only have a temporary loss of hearing sensitivity between the frequencies of 1 and 10 kHz), and can be of varying amounts (for example, an animal's hearing sensitivity might be reduced initially by only 6 dB or reduced by 30 dB). PTS is permanent, but some recovery is possible. PTS can also occur 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 can 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. For intermittent sounds, less TS could occur than compared to a continuous exposure with the same energy (some recovery could occur between intermittent exposures depending on the duty cycle between sounds) (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, prolonged exposure to sounds 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 mid- and high-frequency active sonar (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 marine mammals, published data are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise (Finneran *et al.,* 2000, 2002b, 2003, 2005a, 2007, 2010a, 2010b; Finneran and Schlundt, 2010; Lucke *et al.,* 2009; Mooney *et al.,* 2009a, 2009b; Popov *et al.,* 2011a, 2011b; Kastelein *et al.,* 2012a; Schlundt *et al.,* 2000; Nachtigall *et al.,* 2003, 2004). For pinnipeds in water, data are limited to measurements of TTS in harbor seals, an elephant seal, and California sea lions (Kastak *et al.,* 1999, 2005; Kastelein *et al.,* 2012b).

Marine mammal hearing plays a critical role in communication with conspecifics, and 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 occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts. Also, depending on the degree and frequency range, the effects of PTS on an animal could range in severity, although it is considered generally more serious because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.,* 2007), so one can infer that strategies exist for coping with this condition to some degree, though likely not without cost.

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

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. 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. Recent research with *ex vivo* supersaturated bovine tissues suggested that, for a 37 kHz signal, a sound exposure of approximately 215 dB referenced to (re) 1 μPa would be required before microbubbles became destabilized and grew (Crum *et al.,* 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re 1 μPa at 1 m, a whale would need to be within 10 m (33 ft.) of the sonar dome to be exposed to such sound levels. Furthermore, tissues in the study were supersaturated by exposing them to pressures of 400–700 kilopascals for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400–700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser *et al.,* 2001; Saunders *et al.,* 2008). It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings. Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

Yet another hypothesis (decompression sickness) has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson *et al.,* 2003; Fernandez *et al.,* 2005; Fernández *et al.,* 2012). 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). Crum and Mao (1996) hypothesized that received levels would have to exceed 190 dB in order for there to be the possibility of significant bubble growth due to supersaturation of gases in the blood (*i.e.,* rectified diffusion). More recent work conducted by Crum *et al.* (2005) demonstrated the possibility of rectified diffusion for short duration signals, but at SELs and tissue saturation levels that are highly improbable to occur in diving marine mammals. To date, energy levels (ELs) predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated (NOAA, 2002b). Although it has been argued that traumas from some recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.,* 2003), there is no conclusive evidence of this. However, Jepson *et al.* (2003, 2005) and Fernandez *et al.* (2004, 2005, 2012) concluded that in vivo bubble formation, which may be exacerbated by deep, long-duration, repetitive dives may explain why beaked whales appear to be particularly vulnerable to sonar exposures. Further investigation is needed to further assess the potential validity of these hypotheses. More information regarding hypotheses that attempt to explain how behavioral responses to non-impulsive sources can lead to strandings is included in the Stranding and Mortality section.

Acoustic Masking

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

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

Richardson *et al.* (1995b) argued that the maximum radius of influence of an industrial noise (including broadband low-frequency sound transmission) on a marine mammal is the distance from the source to the point at which the noise can barely be heard. This range is determined by either the hearing sensitivity of the animal or the background noise level present. Industrial masking is most likely to affect some species' ability to detect communication calls and natural sounds (*i.e.,* surf noise, prey noise, etc.; Richardson *et al.,* 1995).

The echolocation calls of toothed whales are subject to masking by high-frequency sound. Human data indicate low-frequency sound can mask high-frequency sounds (*i.e.,* upward masking). Studies on captive odontocetes by Au *et al.* (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (*e.g.,* adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high-frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use to communicate (Zaitseva *et al.,* 1980). A recent study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

The functional hearing ranges of mysticetes, odontocetes, and pinnipeds underwater all encompass the frequencies of the sonar sources used in the Navy's low-frequency (LF)/MFAS/HFAS training exercises. Additionally, almost all species' vocal repertoires span across the frequencies of these sonar 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 sonar, which accounts for a large number of the takes of marine mammals (because of the source strength and number of hours it is conducted), the pulse length and low duty cycle of the MFAS/HFAS signal makes it less likely that masking would 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 it drops to the level of ambient noise (Brenowitz, 2004; Brumm *et al.,* 2004; Lohr *et al.,* 2003). Animals are also aware of environmental conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which 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 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 sometimes 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 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 function, which impairs those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and its fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called ''distress'' (Seyle, 1950) or ''allostatic loading'' (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 experiments; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005; Reneerkens *et al.,* 2002; Thompson and Hamer, 2000). Information has also been collected on the physiological responses of marine mammals to exposure to anthropogenic sounds (Fair and Becker, 2000; Romano *et al.,* 2002; Wright *et al.,* 2008). Various efforts have been undertaken to investigate the impact from vessels (both whale-watching and general vessel traffic noise), and demonstrated impacts do occur (Bain, 2002; Erbe, 2002; Noren et al., 2009; Williams *et al.,* 2006, 2009, 2014a, 2014b; Read *et al.,* 2014; Rolland *et al.,* 2012; Pirotta *et al.,* 2015). This body of research for the most part has investigated impacts associated with the presence of chronic stressors, which differ significantly from the proposed Navy training activities in the GOA TMAA. For example, in an analysis of energy costs to killer whales, Williams et al. (2009) suggested that whale-watching in Canada's Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance, which could carry higher costs than other measures of behavioral change might suggest. Ayres *et al.* (2012) recently reported on research in the Salish Sea (Washington state) involving the measurement of southern resident killer whale fecal hormones to assess two potential threats to the species recovery: Lack of prey (salmon) and impacts to behavior from vessel traffic. Ayres *et al.* (2012) suggested that the lack of prey overshadowed any population-level physiological impacts on southern resident killer whales from vessel traffic. Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. In a conceptual model developed by the Population Consequences of Acoustic Disturbance (PCAD) working group, serum hormones were identified as possible indicators of behavioral effects that are translated into altered rates of reproduction and mortality. The Office of Naval Research hosted a workshop (Effects of Stress on Marine Mammals Exposed to Sound) in 2009 that focused on this very topic (ONR, 2009).

Studies of other marine animals and terrestrial animals would also lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as ''distress'' upon exposure to high frequency, mid-frequency and low-frequency sounds. For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (for example, elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiological stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b), for example, identified noise-induced physiological transient stress responses in hearing-specialist fish (*i.e.,* goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

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

Behavioral Disturbance

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately pre-disposed to respond to certain sounds in certain ways) (Southall *et al.,* 2007). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.,* calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.,* 2007). Individuals (of different age, gender, reproductive status, etc.) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.,* proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone. Ellison *et al.* (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. They recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (*i.e.,* is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this ''exposure context,'' as described, greatly influences the type of behavioral response exhibited by the animal. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large scales and large periods of time. While contextual elements of this sort are typically not included in calculations to quantify take, they are often considered qualitatively (where supporting information is available) in the subsequent analysis that seeks to assess the likely consequences of sound exposures above a certain level.

Exposure of marine mammals to sound sources can result in no response or responses including, but not limited to: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.,* 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. More recent reviews (Nowacek *et al.,* 2007; Ellison *et al.,* 2012) address studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sub-sections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

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 presence of predators have occurred (Connor and Heithaus, 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England, 2001).

Response to Predator—Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke *et al.,* 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

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

Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson *et al.,* 2003). Although hypothetical, discussions surrounding this potential process are controversial.

Foraging—Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.,* bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western grey whales off the coast of Russia (Yazvenko *et al.,* 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen *et al.,* 2006). However, Miller *et al.* (2009) reported buzz rates (a proxy for feeding) 19 percent lower during exposure to distant signatures of seismic airguns. Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source 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 levels were 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. Blue whales exposed to simulated mid-frequency sonar in the Southern California Bight were less likely to produce low frequency calls usually associated with feeding behavior (Melcón *et al.,* 2012). However, Melcon *et al.* (2012) were unable to determine if suppression of low frequency calls reflected a change in their feeding performance or abandonment of foraging behavior and indicated that implications of the documented responses are unknown. Further, it is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. In contrast, blue whales increased their likelihood of calling when ship noise was present, and decreased their likelihood of calling in the presence of explosive noise, although this result was not statistically significant (Melcón *et al.,* 2012). Additionally, the likelihood of an animal calling decreased with the increased received level of mid-frequency sonar, beginning at a SPL of approximately 110–120 dB re 1 μPa (Melcón *et al.,* 2012). Results from the 2010–2011 field season of an ongoing behavioral response study in Southern California waters indicated that, in some cases and at low received levels, tagged blue whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall *et al.,* 2011; Southall *et al.,* 2012b). 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. Goldbogen *et al.,* (2013) monitored behavioral responses of tagged blue whales located in feeding areas when exposed simulated MFA sonar. Responses varied depending on behavioral context, with deep feeding whales being more significantly affected (*i.e.,* generalized avoidance; cessation of feeding; increased swimming speeds; or directed travel away from the source) compared to surface feeding individuals that typically showed no change in behavior. Non-feeding whales also seemed to be affected by exposure. The authors indicate that disruption of feeding and displacement could impact individual fitness and health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since unconsumed prey would likely still be available in the environment in most cases following the cessation of acoustic exposure.

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

Social Relationships—Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (*e.g.,* caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. Long-term disruptions of mother/calf pairs or mating displays 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; Roland *et al.,* 2012). Killer whales off the northwestern coast of the U.S. 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; NOAA, 2014b). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles *et al.,* 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

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

Maybaum (1993) conducted sound playback experiments to assess the effects of MFAS 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 behavior, movement, and underwater vocalizations. The two types of sonar signals (which both contained 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 fitted with D-tags were exposed to mid-frequency active sonar (Source A: A 1.0 second upsweep 209 dB @ 1–2 kHz every 10 seconds for 10 minutes; Source B: With a 1.0 second upsweep 197 dB @ 6–7 kHz every 10 seconds for 10 minutes). 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 killer whales were consistent with the results of other studies.

In 2007, the first in a series of behavioral response studies, a collaboration by the Navy, NMFS, and other scientists showed one beaked whale (*Mesoplodon densirostris*) responding to an MFAS playback. Tyack *et al.* (2011) 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 results are from a single experiment and a greater sample size is needed before robust and definitive conclusions can be drawn.

Tyack *et al.* (2011) also indicates that Blainville's beaked whales 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.

Stimpert *et al.* (2014) tagged a Baird's beaked whale, which was subsequently exposed to simulated MFAS. Received levels of sonar on the tag increased to a maximum of 138 dB re 1µPa, which occurred during the first exposure dive. Some sonar received levels could not be measured due to flow noise and surface noise on the tag.

Results from a 2007–2008 study conducted near the Bahamas showed a change in diving behavior of an adult Blainville's beaked whale to playback of MFAS and predator sounds (Boyd *et al.,* 2008; Southall *et al.* 2009; Tyack *et al.,* 2011). Reaction to mid-frequency sounds included premature cessation of clicking and termination of a foraging dive, and a slower ascent rate to the surface. Results from a similar behavioral response study in southern California waters have been presented for the 2010–2011 field season (Southall *et al.* 2011; DeRuiter *et al.,* 2013b). DeRuiter *et al.* (2013b) presented results from two Cuvier's beaked whales that were tagged and exposed to simulated MFAS during the 2010 and 2011 field seasons of the southern California behavioral response study. The 2011 whale was also incidentally exposed to MFAS from a distant naval exercise. Received levels from the MFAS signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 µPa root mean square (rms), respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (*e.g.,* source proximity, controlled source ramp-up) may have been a significant factor. Specifically, this result suggests that caution is needed when using marine mammal response data collected from smaller, nearer sound sources to predict at what received levels animals may repond to larger sound sources that are significantly farther away—as the distance of the source appears to be an important contextual variable and animals may be less responsive to sources at notably greater distances. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale. Similarly, beaked whales exposed to sonar during British training exercises stopped foraging (DSTL, 2007), and preliminary results of controlled playback of sonar may indicate feeding/foraging disruption of killer whales and sperm whales (Miller *et al.,* 2011).

In the 2007–2008 Bahamas study, playback sounds of a potential predator—a killer whale—resulted in a similar but more pronounced reaction, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area (Boyd *et al.,* 2008; Southall *et al.* 2009; Tyack *et al.,* 2011). The authors noted, however, that the magnified reaction to the predator sounds could represent a cumulative effect of exposure to the two sound types since killer whale playback began approximately 2 hours after mid-frequency source playback. Pilot whales and killer whales off Norway also exhibited horizontal avoidance of a transducer with outputs in the mid-frequency range (signals in the 1–2 kHz and 6–7 kHz ranges) (Miller *et al.,* 2011). Additionally, separation of a calf from its group during exposure to MFAS playback was observed on one occasion (Miller *et al.,* 2011; 2012). Miller *et al.* (2012) noted that this single observed mother-calf separation was unusual for several reasons, including the fact that the experiment was conducted in an unusually narrow fjord roughly 1 km wide and that the sonar exposure was started unusually close to the pod including the calf. Both of these factors could have contributed to calf separation. In contrast, preliminary analyses suggest that none of the pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall *et al.,* 2009).

Through analysis of the behavioral response studies, a preliminary overarching effect of greater sensitivity to all anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall *et al.,* 2009). Therefore, recent studies have focused specifically on beaked whale responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Defence Science and Technology Laboratory, 2007; Claridge and Durban, 2009; Moretti *et al.,* 2009; McCarthy *et al.,* 2011; Miller *et al.,* 2012; Southall *et al.,* 2011, 2012a, 2012b, 2013, 2014; Tyack *et al.,* 2011). In the Bahamas, Blainville's beaked whales located on the range will move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge and Durban 2009; Moretti *et al.,* 2009; McCarthy *et al.,* 2011; Tyack *et al.,* 2011). Moretti *et al.* (2014) used recordings from seafloor-mounted hydrophones at the Atlantic Undersea Test and Evaluation Center (AUTEC) to analyze the probability of Blainsville's beaked whale dives before, during, and after Navy sonar exercises.

Orientation—A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

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 sonar 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 to 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-impulsive sounds include data gathered both in the field and the laboratory and related to several different sound sources (of varying similarity to MFAS/HFAS) including: AHDs, ATOC, various non-pulse sounds used in underwater data communication, underwater drilling, and construction noise. Few studies exist with enough information to include them in the analysis. The limited data suggested that exposures to non-pulse sounds between 90 and 140 dB generally do not result in strong behavioral responses in pinnipeds in water, but no data exist at higher received levels.

Potential Effects of Behavioral Disturbance

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

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called ''attentional capture'' occurs when a stimulus (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 subconsciously (for example, when an animal hears sounds that it associates with the approach of a predator) and the shift in attention can be sudden (Dukas, 2002; van Rij, 2007). Once a stimulus has captured an animal's attention, the animal can respond by ignoring the stimulus, assuming a ''watch and wait'' posture, or treat the stimulus as a disturbance and respond accordingly, which includes scanning for the source of the stimulus or ''vigilance'' (Cowlishaw *et al.,* 2004).

Vigilance is normally an adaptive behavior that helps animals determine the presence or absence of predators, assess their distance from conspecifics, or to attend cues from prey (Bednekoff and Lima, 1998; Treves, 2000). Despite those benefits, however, vigilance has a cost of time; when animals focus their attention on specific environmental cues, they are not attending to other activities such as foraging. These costs have been documented best in foraging animals, where vigilance has been shown to substantially reduce feeding rates (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002). Animals will spend more time being vigilant, which may translate to less time foraging or resting, when disturbance stimuli approach them more directly, remain at closer distances, have a greater group size (for example, multiple surface vessels), or when they co-occur with times that an animal perceives increased risk (for example, when they are giving birth or accompanied by a calf). Most of the published literature, however, suggests that direct approaches will increase the amount of time animals will dedicate to being vigilant. For example, bighorn sheep and Dall's sheep dedicated more time being vigilant, and less time resting or foraging, when aircraft made direct approaches over them (Frid, 2001; Stockwell *et al.,* 1991).

Several authors have established that long-term and intense disturbance stimuli can cause population declines by reducing the body condition of individuals that have been disturbed, followed by reduced reproductive success, reduced survival, or both (Daan *et al.,* 1996; Madsen, 1994; White, 1983). For example, Madsen (1994) reported that pink-footed geese 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 disturbed by all-terrain vehicles (Yarmoloy *et al.,* 1988), caribou disturbed by seismic exploration blasts (Bradshaw *et al.,* 1998), caribou disturbed by low-elevation military jet-fights (Luick *et al.,* 1996), and caribou disturbed by low-elevation jet flights (Harrington and Veitch, 1992). Similarly, a study of elk 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 reported that bears disturbed by hikers reduced their energy intake by an average of 12 kcal/minute (50.2 x 10^3kJ/minute), 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 5-day period did not cause any sleep deprivation or stress effects such as changes in cortisol or epinephrine levels.

Lusseau and Bejder (2007) present data from three long-term studies illustrating the connections between disturbance from whale-watching boats and population-level effects in cetaceans. In Sharks Bay Australia, the abundance of bottlenose dolphins was compared within adjacent control and tourism sites over three consecutive 4.5-year periods of increasing tourism levels. Between the second and third time periods, in which tourism doubled, dolphin abundance decreased by 15 percent in the tourism area and did not change significantly in the control area. In Fiordland, New Zealand, two populations (Milford and Doubtful Sounds) of bottlenose dolphins with tourism levels that differed by a factor of seven were observed and significant increases in travelling time and decreases in resting time were documented for both. Consistent short-term avoidance strategies were observed in response to tour boats until a threshold of disturbance was reached (average 68 minutes between interactions), after which the response switched to a longer term habitat displacement strategy. For one population tourism only occurred in a part of the home range, however, tourism occurred throughout the home range of the Doubtful Sound population and once boat traffic increased beyond the 68-minute threshold (resulting in abandonment of their home range/preferred habitat), reproductive success drastically decreased (increased stillbirths) and abundance decreased significantly (from 67 to 56 individuals in short period). Last, in a study of northern resident killer whales off Vancouver Island, exposure to boat traffic was shown to reduce foraging opportunities and increase traveling time. A simple bioenergetics model was applied to show that the reduced foraging opportunities equated to a decreased energy intake of 18 percent, while the increased traveling incurred an increased energy output of 3–4 percent, which suggests that a management action based on avoiding interference with foraging might be particularly effective.

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Substantive behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than 1 day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). Note that there is a difference between multiple-day substantive behavioral reactions and multiple-day anthropogenic activities. For example, just because an at-sea exercises last for multiple days does not necessarily mean that individual animals are either exposed to those exercises for multiple days or, further, exposed in a manner resulting in a sustained multiple day substantive behavioral responses.

In order to understand how the effects of activities may or may not impact stocks and populations of marine mammals, it is necessary to understand not only what the likely disturbances are going to be, but how those disturbances may affect the reproductive success and survivorship of individuals, and then how those impacts to individuals translate to population changes. Following on the earlier work of a committee of the U.S. National Research Council (NRC, 2005), New *et al.* (2014), in an effort termed the Potential Consequences of Disturbance (PCoD), outline an updated conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics (below). As depicted, behavioral and physiological changes can either have direct (acute) effects on vital rates, such as when changes in habitat use or increased stress levels raise the probability of mother-calf separation or predation, or they can have indirect and long-term (chronic) effects on vital rates, such as when changes in time/energy budgets or increased disease susceptibility affect health, which then affects vital rates (New *et al.,* 2014). In addition to outlining this general framework and compiling the relevant literature that supports it, New *et al.* (2014) have chosen four example species for which extensive long-term monitoring data exist (southern elephant seals, North Atlantic right whales, Ziphidae beaked whales, and bottlenose dolphins) and developed state-space energetic models that can be used to effectively forecast longer-term, population-level impacts from behavioral changes. While these are very specific models with very specific data requirements that cannot yet be applied broadly to project-specific risk assessments, they are a critical first step.

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 U.S. can be found in section 410 of the MMPA (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). For reference, between 2001 and 2009, there was an annual average of 1,400 cetacean strandings and 4,300 pinniped strandings along the coasts of the continental U.S. and Alaska (NMFS, 2011).

Several sources have published lists of mass stranding events of cetaceans in an attempt to identify relationships between those stranding events and military sonar (Hildebrand, 2004; IWC, 2005; Taylor *et al.,* 2004). For example, based on a review of stranding records between 1960 and 1995, the International Whaling Commission (2005) identified ten mass stranding events of Cuvier's beaked whales had been reported and one mass stranding of four Baird's beaked whale. 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 tactical mid-frequency sonar, one of those seven had been associated with the use of tactical low-frequency sonar, and the remaining stranding event had been associated with the use of seismic airguns.

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

Between 1960 and 2006, 48 strandings (68 percent) involved beaked whales, three (4 percent) involved dolphins, and 14 (20 percent) involved whale species. Cuvier's beaked whales were involved in the greatest number of these events (48 or 68 percent), followed by sperm whales (seven or 10 percent), and Blainville's and Gervais' beaked whales (four each or 6 percent). Naval activities (not just activities conducted by the U.S. Navy) that might have involved active sonar are reported to have coincided with nine or 10 (13 to 14 percent) of those stranding events. Between the mid-1980s and 2003 (the period reported by the International Whaling Commission), NMFS identified reports of 44 mass cetacean stranding events of which at least seven were coincident with naval exercises that were using MFAS.

Strandings Associated With Impulsive Sound

Silver Strand—During a Navy training event on March 4, 2011 at the Silver Strand Training Complex in San Diego, California, three or possibly four dolphins were killed in an explosion. During an underwater detonation training event, a pod of 100 to 150 long-beaked common dolphins were observed moving towards the 700-yd (640.1-m) exclusion zone around the explosive charge, monitored by personnel in a safety boat and participants in a dive boat. Approximately 5 minutes remained on a time-delay fuse connected to a single 8.76 lb (3.97 kg) explosive charge (C–4 and detonation cord). Although the dive boat was placed between the pod and the explosive in an effort to guide the dolphins away from the area, that effort was unsuccessful and three long-beaked common dolphins near the explosion died. In addition to the three dolphins found dead on March 4, the remains of a fourth dolphin were discovered on March 7, 2011 near Ocean Beach, California (3 days later and approximately 11.8 mi. [19 km] from Silver Strand where the training event occurred), which might also have been related to this event. Association of the fourth stranding with the training event is uncertain because dolphins strand on a regular basis in the San Diego area. Details such as the dolphins' depth and distance from the explosive at the time of the detonation could not be estimated from the 250 yd (228.6 m) standoff point of the observers in the dive boat or the safety boat.

These dolphin mortalities are the only known occurrence of a U.S. Navy training or testing event involving impulsive energy (underwater detonation) that caused mortality or injury to a marine mammal (of note, the time-delay firing underwater explosive training activity implicated in the March 4 incident is not proposed for the training activities in the GOA Study Area). Despite this being a rare occurrence, the Navy has reviewed training requirements, safety procedures, and possible mitigation measures and implemented changes to reduce the potential for this to occur in the future. Discussions of procedures associated with underwater explosives training and other training events are presented in the Proposed Mitigation section.

Kyle of Durness, Scotland—On July 22, 2011 a mass stranding event involving long-finned pilot whales occurred at Kyle of Durness, Scotland. An investigation by Brownlow *et al.* (2015) considered unexploded ordnance detonation activities at a Ministry of Defense bombing range, conducted by the Royal Navy prior to and during the strandings, as a plausible contributing factor in the mass stranding event. While Brownlow *et al.* (2015) concluded that the serial detonations of underwater ordnance were an influential factor in the mass stranding event (along with presence of a potentially compromised animal and navigational error in a topographically complex region) they also suggest that mitigation measures—which included observations from a zodiac only and by personnel not experienced in marine mammal observation, among other deficiencies—were likely insufficient to assess if cetaceans were in the vicinity of the detonations. The authors also cite information from the Ministry of Defense indicating ''an extraordinarily high level of activity'' (*i.e.,* frequency and intensity of underwater explosions) on the range in the days leading up to the stranding.

Strandings Associated With MFAS

Over the past 16 years, there have been five stranding events coincident with military mid-frequency sonar use in which exposure to sonar is believed to have been a contributing factor: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006). Additionally, in 2004, during the Rim of the Pacific (RIMPAC) exercises, between 150 and 200 usually pelagic melon-headed whales occupied the shallow waters of Hanalei Bay, Kauai, Hawaii for over 28 hours. NMFS determined that MFAS was a plausible, if not likely, contributing factor in what may have been a confluence of events that led to the stranding. A number of other stranding events coincident with the operation of mid-frequency sonar, 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 stranding events, the Bahamas (2000), was associated with exercises conducted by the U.S. Navy. Most recently, the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales in Antsohihy, Madagascar released its final report suggesting that the stranding was likely initially triggered by an industry seismic survey. This report suggests that the operation of a commercial high-powered 12 kHz multi-beam echosounder during an industry seismic survey was a plausible and likely initial trigger that caused a large group of melon-headed whales to leave their typical habitat and then ultimately strand as a result of secondary factors such as malnourishment and dehydration. The report indicates that the risk of this particular convergence of factors and ultimate outcome is likely very low, but recommends that the potential be considered in environmental planning. Because of the association between tactical mid-frequency active sonar use and a small number of marine mammal strandings, the Navy and NMFS have been considering and addressing the potential for strandings in association with Navy activities for years. In addition to a suite of mitigation intended to more broadly minimize impacts to marine mammals, the Navy and NMFS have a detailed Stranding Response Plan that outlines reporting, communication, and response protocols intended both to minimize the impacts of, and enhance the analysis of, any potential stranding in areas where the Navy operates.

Greece (1996)—Twelve Cuvier's beaked whales stranded atypically (in both time and space) along a 38.2-km strand of the Kyparissiakos Gulf coast on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the North Atlantic Treaty Organization (NATO) research vessel *Alliance* was conducting 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 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. 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. 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. The analysis of this stranding event provided support for, but no clear evidence for, the cause-and-effect relationship of tactical sonar training activities and beaked whale strandings (Cox *et al.,* 2006).

Bahamas (2000)—NMFS and the Navy prepared a joint report addressing the multi-species stranding in the Bahamas in 2000, which took place within 24 hours of U.S. Navy ships using MFAS as they passed through the Northeast and Northwest Providence Channels on March 15–16, 2000. The ships, which operated both AN/SQS–53C and AN/SQS–56, moved through the channel while emitting sonar 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 (five Cuvier's beaked whales, one Blainville's beaked whale, and the spotted dolphin), while the other 10 were returned to the water alive (though their ultimate fate is unknown). As discussed in the Bahamas report (DOC/DON, 2001), there is no likely association between the minke whale and spotted dolphin strandings and the operation of MFAS.

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

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

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

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

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

Even though no definitive causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004): Exercises were conducted in areas of at least 547 fathoms (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 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); and exercises took place in an area surrounded by landmasses 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 three 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 sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson *et al.,* 2003; Fernández *et al.,* 2005).

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 it is not known 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 an inexperienced mother with her first 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 U.S. 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. 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 suggests 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. 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, NMFS 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 hours; no known active sonar transmissions occurred in the vicinity of that event. The Rota incident led to scientific debate regarding what, if any, relationship the event had to the simultaneous events in Hawaii and whether they might be related by some common factor (*e.g.,* there was a full moon on July 2, 2004, as well as during other melon-headed whale strandings and nearshore aggregations (Brownell *et al.,* 2009; Lignon *et al.,* 2007; Mobley *et al.,* 2007). Brownell *et al.* (2009) compared the two incidents, along with one other stranding incident at Nuka Hiva in French Polynesia and normal resting behaviors observed at Palmyra Island, in regard to physical features in the areas, melon-headed whale behavior, and lunar cycles. Brownell *et al.,* (2009) concluded that the rapid entry of the whales into Hanalei Bay, their movement into very shallow water far from the 100-m contour, their milling behavior (typical pre-stranding behavior), and their reluctance to leave the bay constituted an unusual event that was not similar to the events that occurred at Rota (but was similar to the events at Palmyra), which appear to be similar to observations of melon-headed whales resting normally at Palmyra Island. Additionally, there was no correlation between lunar cycle and the types of behaviors observed in the Brownell *et al.* (2009) examples.

Spain (2006)—The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26, 2006, on the southeast coast of Spain, near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. The first three animals were located near the town of Mojacar and the fourth animal was found dead, a few kilometers north of the first three animals. From January 25–26, 2006, Standing 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 hours) 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).

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 (*Stenella coeruleoalba, Kogia breviceps* and *Balaenoptera acutorostrata*) have stranded, but in much lower numbers and less consistently than beaked whales.

Based on the evidence available, however, NMFS cannot determine whether (a) Cuvier's beaked whale is more prone to injury from high-intensity sound than other species; (b) their behavioral responses to sound makes them more likely to strand; or (c) they are more likely to be exposed to MFAS than other cetaceans (for reasons that remain unknown). Because the association between active sonar exposures and marine mammals mass stranding events is not consistent—some marine mammals strand without being exposed to 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 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 (for example, the ''canyon areas'' that are cited in the Bahamas stranding event; see D'Spain and D'Amico, 2006), may respond to active sonar by swimming into shallow waters to avoid further exposures and strand if they were not able to swim back to deeper waters. Second, beaked whales exposed to active sonar might alter their dive behavior. Changes in their dive behavior might cause them to remain at the surface or at depth for extended periods of time which could lead to hypoxia directly by increasing their oxygen demands or indirectly by increasing their energy expenditures (to remain at depth) and increase their oxygen demands as a result. If beaked whales are at depth when they detect a ping from an active sonar transmission and change their dive profile, this could lead to the formation of significant gas bubbles, which could damage multiple organs or interfere with normal physiological function (Cox *et al.,* 2006; Rommel *et al.,* 2006; Zimmer and Tyack, 2007). Baird *et al.* (2005) found that slow ascent rates from deep dives and long periods of time spent within 50 m of the surface were typical for both Cuvier's and Blainville's beaked whales, the two species involved in mass strandings related to naval sonar. These two behavioral mechanisms may be necessary to purge excessive dissolved nitrogen concentrated in their tissues during their frequent long dives (Baird *et al.,* 2005). Baird *et al.* (2005) further suggests that abnormally rapid ascents or premature dives in response to high-intensity sonar could indirectly result in physical harm to the beaked whales, through the mechanisms described above (gas bubble formation or non-elimination of excess nitrogen).

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

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 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 ascent 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 mid-frequency range sonar (Jepson *et al.,* 2003; Fernandez *et al.,* 2005; Fernández *et al.,* 2012) 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. 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.

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

Despite the many theories involving bubble formation (both as a direct cause of injury (see Acoustically Mediated Bubble Growth Section) and an indirect cause of stranding (See Behaviorally Mediated Bubble Growth Section), Southall *et al.,* (2007) summarizes that 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.

Strandings in the GOA TMAA

Northern Edge—Prior to the start of Northern Edge 2015 (a joint training exercise in the GOA TMAA hosted by Alaskan Command) and before Navy vessels were in the Gulf of Alaska, the Navy was informed by NMFS of various marine mammals found dead in the Gulf of Alaska and that NMFS was attempting to obtain samples from them. It has been reported that at least nine drifting and floating fin whales and multiple pinniped species were found in Gulf of Alaska waters as early as May 23, 2015 between Kodiak Island to Unimak Pass. NMFS is still investigating these findings but a possible cause referenced has been an algal bloom. During Northern Edge 2015, two Navy vessels training in the Gulf of Alaska on separate days encountered a well-decayed whale carcass. This whale or whales may possibly be the same animal observed by both ships, and given the stage of decomposition, might have been one of the floating whales reported by other entities to NMFS before Northern Edge began. The ships followed Navy reporting procedures and the information was provided to NMFS to aid in the investigation. There is no causal connection with Navy activities given the advanced stage of decomposition and gap of timing of when Navy maritime training events began.

Impulsive Sources

Underwater explosive detonations send a shock wave and sound energy through the water and can release gaseous by-products, create an oscillating bubble, or cause a plume of water to shoot up from the water surface. The shock wave and accompanying noise are of most concern to marine animals. Depending on the intensity of the shock wave and size, location, and depth of the animal, an animal can be injured, killed, suffer non-lethal physical effects, experience hearing related effects with or without behavioral responses, or exhibit temporary behavioral responses or tolerance from hearing the blast sound. Generally, exposures to higher levels of impulse and pressure levels would result in greater 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 damage associated with sound energy from detonations can be theoretically distinct from injury from the shock wave, particularly farther from the explosion. If a noise is audible to an animal, it has the potential to damage the animal's hearing by causing decreased sensitivity (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 compared to MFAS/HFAS. However, though the nature of the sound waves emitted from an explosion are different (in shape and rise time) from MFAS/HFAS, NMFS still anticipates the same sorts of behavioral responses to result from repeated explosive detonations (a smaller range of likely less severe responses (*i.e.,* not rising to the level of MMPA harassment) would be expected to occur as a result of exposure to a single explosive detonation that was not powerful enough or close enough to the animal to cause TTS or injury).

Baleen whales have shown a variety of responses to impulse sound sources, including avoidance, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Richardson *et al.,* 1995; Gordon *et al.,* 2003; Southall, 2007). While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson *et al.,* 1995), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 μPa rms. Additionally, Malme *et al.* (1988) observed clear changes in diving and respiration patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 μPa.

Gray whales migrating along the U.S. west coast showed avoidance responses to seismic vessels by 10 percent of animals at 164 dB re 1 μPa, and by 90 percent of animals at 190 dB re 1 μPa, with similar results for whales in the Bering Sea (Malme 1986, 1988). In contrast, noise from seismic surveys was not found to impact feeding behavior or exhalation rates while resting or diving in western gray whales off the coast of Russia (Yazvenko *et al.,* 2007; Gailey *et al.,* 2007).

Humpback whales showed avoidance behavior at ranges of 5–8 km from a seismic array during observational studies and controlled exposure experiments in western Australia (McCauley, 1998; Todd *et al.,* 1996) found no clear short-term behavioral responses by foraging humpbacks to explosions associated with construction operations in Newfoundland, but did see a trend of increased rates of net entanglement and a shift to a higher incidence of net entanglement closer to the noise source.

Seismic pulses at average received levels of 131 dB re 1 micropascal squared second (μPa²-s) caused blue whales to increase call production (Di Iorio and Clark, 2010). In contrast, McDonald *et al.* (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the seismic vessel (estimated received level 143 dB re 1 μPa peak-to-peak). These studies demonstrate that even low levels of noise received far from the noise source can induce behavioral responses.

Madsen *et al.* (2006) and Miller *et al.* (2009) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic airgun surveys. Sound sources were from approximately 2 to 7 nm away from the whales and based on multipath propagation received levels were as high as 162 dB SPL re 1 μPa with energy content greatest between 0.3 and 3.0 kHz (Madsen, 2006). The whales showed no horizontal avoidance, although the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing (Miller *et al.,* 2009). The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than control periods, suggesting subtle effects of noise on foraging behavior (Miller *et al.,* 2009). Captive bottlenose dolphins sometimes vocalized after an exposure to impulse sound from a seismic watergun (Finneran *et al.,* 2010a).

A review of behavioral reactions by pinnipeds to impulse noise can be found in Richardson *et al.* (1995) and Southall *et al.* (2007). Blackwell *et al.* (2004) observed that ringed seals exhibited little or no reaction to pipe-driving noise with mean underwater levels of 157 dB re 1 μPa rms and in air levels of 112 dB re 20 μPa, suggesting that the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an impulse source at levels of 165–170 dB re 1 μPa (Finneran *et al.,* 2003b). Experimentally, Götz and Janik (2011) tested underwater, startle responses to a startling sound (sound with a rapid rise time and a 93 dB sensation level [the level above the animal's threshold at that frequency]) and a non-startling sound (sound with the same level, but with a slower rise time) in wild-captured gray seals. The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the non-startling treatment did not react or habituated during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal's response of habituation.

Vessels

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 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 and also appear to increase the chance of severe injuries or death. While modeling studies have suggested that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999; Knowlton *et al.,* 1995), this is inconsistent with Silber *et al.* (2010), which demonstrated that there is no such relationship (*i.e.,* hydrodynamic forces are independent of speed).

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).

There are no records of any Navy vessel strikes to marine mammals during training or testing activities in the Study Area. There have been Navy vessel strikes of large whales in areas outside the Study Area, such as Hawaii and Southern California. However, these areas differ significantly from the Study Area given that both Hawaii and Southern California have a much higher number of Navy vessel activities and much higher densities of large whales.

Other efforts have been undertaken to investigate the impact from vessels (both whale-watching and general vessel traffic noise) and demonstrated impacts do occur (Bain, 2002; Erbe, 2002; Lusseau, 2009; Williams *et al.,* 2006, 2009, 2011b, 2013, 2014a, 2014b; Noren *et al.,* 2009; Read *et al.,* 2014; Rolland *et al.,* 2012; Pirotta *et al.,* 2015). This body of research for the most part has investigated impacts associated with the presence of chronic stressors, which differ significantly from generally intermittent Navy training and testing activities. For example, in an analysis of energy costs to killer whales, Williams *et al.* (2009) suggested that whale-watching in the Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance, which could carry higher costs than other measures of behavioral change might suggest. Ayres *et al.* (2012) recently reported on research in the Salish Sea involving the measurement of southern resident killer whale fecal hormones to assess two potential threats to the species recovery: Lack of prey (salmon) and impacts to behavior from vessel traffic. Ayres *et al.* (2012) suggested that the lack of prey overshadowed any population-level physiological impacts on southern resident killer whales from vessel traffic.

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 because of their size, NMFS also believes that the likelihood of a Navy vessel striking a mysticete or sperm whale is also low with the implementation of mitigation measures and the low density of navy ships in the Study Area. 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.

Proposed Mitigation

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.'' NMFS' duty under this ''least practicable adverse impact'' standard is to prescribe mitigation reasonably designed to minimize, to the extent practicable, any adverse population-level impacts, as well as habitat impacts. While population-level impacts are minimized by reducing impacts on individual marine mammals, not all takes have a reasonable potential for translating to population-level impacts. NMFS' objective under the ''least practicable adverse impact'' standard is to design mitigation targeting those impacts on individual marine mammals that are reasonably likely to contribute to adverse population-level effects.

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 and testing activities described in the Navy's LOA application are considered military readiness activities.

In *Conservation Council for Hawaii* v. *National Marine Fisheries Service,* No. 1:13–cv–00684 (D. Hawaii March 31, 2015), the court stated that NMFS ''appear[s] to think that [it] satisf[ies] the statutory 'least practicable adverse impact' requirement with a 'negligible impact' finding.'' In light of the court's decision, we take this opportunity to make clear our position that the ''negligible impact'' and ''least practicable adverse impact'' requirements are distinct, even though the focus of both is on population-level impacts.

A population-level impact is an impact on the population numbers (survival) or growth and reproductive rates (recruitment) of a particular marine mammal species or stock. As we noted in the preamble to our general MMPA implementing regulations, not every population-level impact violates the negligible impact requirement. As we explained, the negligible impact standard does not require a finding that the anticipated take will have ''no effect'' on population numbers or growth rates: ''The statutory standard does not require that the same recovery rate be maintained, rather that no significant effect on annual rates of recruitment or survival occurs . . . [T]he key factor is the significance of the level of impact on rates of recruitment or survival. Only insignificant impacts on long-term population levels and trends can be treated as negligible.'' See 54 FR 40338, 40341–42 (September 29, 1989). Nevertheless, while insignificant impacts on population numbers or growth rates may satisfy the negligible impact requirement, such impacts still must be mitigated, to the extent practicable, under the ''least practicable adverse impact'' requirement. Thus, the negligible impact and least practicable adverse impact requirements are clearly distinct, even though both focus on population-level effects.

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 accomplishing one or more of the general goals listed below:

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

b. Reduce 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. Reduce 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. Reduce 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. Avoid or minimize adverse effects to marine mammal habitat (including acoustic 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—increase the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation (shut-down zone, etc.).

Our final evaluation of measures that meet one or more of the above goals includes consideration of the following factors in relation to one another: The manner in which, and the degree to which, the successful implementation of the mitigation measures is expected to reduce population-level impacts to marine mammal species and stocks and impacts to their habitat; the proven or likely efficacy of the measures; and the practicability of the suite of measures for applicant implementation, including consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

NMFS reviewed the proposed activities and the suite of proposed 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. NMFS worked with the Navy in the development of the Navy's initially proposed measures, which are informed by years of experience and monitoring. Below are the mitigation measures as agreed upon by the Navy and NMFS. For additional details regarding the Navy's mitigation measures, see Chapter 5 in the GOA DSEIS/OEIS.

Lookouts

The Navy will have two types of Lookouts for the purposes of conducting visual observations: Those positioned on ships; and those positioned ashore, in aircraft, or on small boats. Lookouts positioned on ships will diligently observe the air and surface of the water. They will have multiple observation objectives, which include but are not limited to detecting the presence of biological resources and recreational or fishing boats, observing the mitigation zones, and monitoring for vessel and personnel safety concerns.

Due to manning and space restrictions on aircraft, small boats, and some Navy ships, Lookouts for these platforms may be supplemented by the aircraft crew or pilot, boat crew, range site personnel, or shore-side personnel. Lookouts positioned in minimally manned platforms may be responsible for tasks in addition to observing the air or surface of the water (*e.g.,* navigation of a helicopter or small boat). However, all Lookouts will, considering personnel safety, practicality of implementation, and impact on the effectiveness of the activity, comply with the observation objectives described above for Lookouts positioned on ships.

The procedural measures described in the remainder of this section primarily consist of having Lookouts during specific training activities.

All personnel standing watch on the bridge, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare helicopter crews, civilian equivalents, and Lookouts will successfully complete the United States Navy Marine Species Awareness Training prior to standing watch or serving as a Lookout. Additional details on the Navy's Marine Species Awareness Training can be found in the GOA DSEIS/OEIS. The Navy proposes to use one or more Lookouts during the training activities described below, which are organized by stressor category.

Non-Impulsive Sound

Hull Mounted Mid-Frequency Active Sonar

The Navy's current Lookout mitigation measures during training activities involving hull-mounted MFAS include requirements such as the number of personnel on watch and the manner in which personnel are to visually search the area in the vicinity of the ongoing activity.

The Navy is proposing to maintain the number of Lookouts currently implemented for ships using hull-mounted MFAS. Ships using hull-mounted MFAS sources associated with ASW activities at sea (with the exception of ships less than 65 ft. [20 m] in length, which are minimally manned) will have two Lookouts at the forward position. While using hull-mounted MFAS sources underway, vessels less than 65 ft. [20 m] in length and ships that are minimally manned will have one Lookout at the forward position due to space and manning restrictions.

High-Frequency and Non-Hull-Mounted Mid-Frequency Active Sonar

The Navy currently conducts activities using high-frequency and non-hull-mounted MFAS in the Study Area. Non-hull-mounted MFAS training activities include the use of aircraft deployed sonobuoys, helicopter dipping sonar, and submarine sonar. During those activities, the Navy employs the following mitigation measures regarding Lookout procedures:

- Navy aircraft participating in exercises at sea shall conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Helicopters shall observe/survey the vicinity of an ASW training event for 10 minutes before the first deployment of active (dipping) sonar in the water.

The Navy is proposing to continue using the number of Lookouts (one) currently implemented for aircraft conducting non-hull-mounted MFA sonar activities.

Mitigation measures do not currently exist for other high-frequency active sonar activities associated with ASW, or for new platforms; therefore, the Navy is proposing to add a new Lookout and other measures for these activities and on these platforms when conducted in the Study Area. The recommended measure is provided below.

The Navy will have one Lookout on ships conducting high-frequency or non-hull mounted mid-frequency active sonar activities associated with ASW activities at sea.

Explosives and Impulsive Sound

Improved Extended Echo Ranging Sonobuoys

The Navy is not proposing use of Improved Extended Echo Ranging Sonobuoys during the GOA TMAA training activities.

Explosive Signal Underwater Sound Buoys Using >0.5–2.5 Pound Net Explosive Weight

Lookout measures do not currently exist for explosive signal underwater sound (SUS) buoy activities using >0.5–2.5 pound (lb.) net explosive weight (NEW). The Navy is proposing to add this measure. Aircraft conducting SUS activities using >0.5–2.5 lb. NEW will have one Lookout.

Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target

Currently, the Navy employs the following Lookout procedures during gunnery exercises:

- From the intended firing position, trained Lookouts shall survey the mitigation zone for marine mammals prior to commencement and during the exercise as long as practicable.
- If applicable, target towing vessels shall maintain a Lookout. 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 Navy is proposing to continue using the Lookout procedures currently implemented for this activity. The Navy will have one Lookout on the vessel or aircraft conducting small-, medium-, or large-caliber gunnery exercises against a surface target. Towing vessels, if applicable, shall also maintain one Lookout.

Missile Exercises Using a Surface Target

Currently, the Navy employs the following Lookout procedures during missile exercises:

- 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 slowest safe speed.

• Firing or range clearance aircraft must be able to actually see ordnance impact areas.

The Navy is proposing to continue using the Lookout procedures currently implemented for this activity. When aircraft are conducting missile exercises against a surface target, the Navy will have one Lookout positioned in an aircraft.

Bombing Exercises (Explosive)

Currently, the Navy employs the following Lookout procedures during bombing exercises:

• If surface vessels are involved, Lookouts shall survey for floating kelp and marine mammals.

• 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. (460 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: Aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

The Navy is proposing to (1) continue implementing the current measures for bombing exercises, and (2) clarify the number of Lookouts currently implemented for this activity. The Navy will have one Lookout positioned in an aircraft conducting bombing exercises, and trained Lookouts in any surface vessels involved.

Weapons Firing Noise During Gunnery Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for gunnery exercises. The Navy will have one Lookout on the ship conducting explosive and non-explosive gunnery exercises. This may be the same Lookout described for Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target when that activity is conducted from a ship against a surface target.

Sinking Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have two Lookouts (one positioned in an aircraft and one on a vessel) during sinking exercises.

Physical Disturbance and Strike

Vessels

Currently, the Navy employs the following Lookout procedures to avoid physical disturbance and strike of marine mammals during at-sea training:

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

Consistent with other ongoing Navy Phase 2 training and testing (NWTT, MITT, AFTT, HSTT), the Navy is proposing to revise the mitigation measures for this activity as follows: While underway, vessels will have a minimum of one Lookout.

Non-Explosive Practice Munitions

Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target

Currently, the Navy employs the same mitigation measures for non-explosive practice munitions—small-, medium-, and large-caliber gunnery exercises—as described above for Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target.

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. The Navy will have one Lookout during activities involving non-explosive practice munitions (*e.g.,* small-, medium-, and large-caliber gunnery exercises) against a surface target.

Missile Exercises Using a Surface Target

Currently, the Navy employs the same mitigation measures for non-explosive missile exercises (including rockets) using a surface target as described for Missile Exercises Using a Surface Target (explosive).

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. When aircraft are conducting non-explosive missile exercises (including exercises using rockets) against a surface target, the Navy will have one Lookout positioned in an aircraft.

Bombing Exercises

Currently, the Navy employs the same mitigation measures for non-explosive bombing exercises as described for Bombing Exercises (Explosive).

The Navy is proposing to continue using the same Lookout procedures currently implemented for these activities. The Navy will have one Lookout positioned in an aircraft during non-explosive bombing exercises, and trained Lookouts in any surface vessels involved.

Mitigation Zones

The Navy proposes to use mitigation zones to reduce the potential impacts to marine mammals from training activities. Mitigation zones are measured as the radius from a source. Unique to each activity category, each radius represents a distance that the Navy will visually observe to help reduce injury to marine species. Visual detections of applicable marine species will be communicated immediately to the appropriate watch station for information dissemination and appropriate action. If the presence of marine mammals is detected acoustically, Lookouts posted in aircraft and on surface vessels will increase the vigilance of their visual surveillance. As a reference, aerial surveys are typically made by flying at 1,500 ft. (457 m) altitude or lower at the slowest safe speed.

Many of the proposed activities have mitigation measures that are currently being implemented, as required by previous environmental documents or consultations. Most of the current mitigation zones for activities that involve the use of impulsive and non-impulsive sources were originally designed to reduce the potential for onset of TTS. For the GOA DSEIS/OEIS and the LOA application, the Navy updated the acoustic propagation modeling to incorporate updated hearing threshold metrics (*i.e.,* upper and lower frequency limits), updated density data for marine mammals, and factors such as an animal's likely presence at various depths. An explanation of the acoustic propagation modeling process can be found in the Determination of Acoustic Effects on Marine Mammals for the Gulf of Alaska Training Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement technical report (Marine Species Modeling Team, 2014).

As a result of the updates to the acoustic propagation modeling, in some cases the ranges to onset of TTS effects are much larger than previous model outputs. Due to the ineffectiveness and unacceptable operational impacts associated with mitigating these large areas, the Navy is unable to mitigate for onset of TTS for every activity. In this GOA TMAA analysis, the Navy developed each recommended mitigation zone to avoid or reduce the potential for onset PTS, out to the predicted maximum range. In some cases where the ranges to effects are smaller than previous models estimated, the mitigation zones were adjusted accordingly to provide consistency across the measures. Mitigating to the predicted maximum range to PTS consequently also mitigates to the predicted maximum range to onset mortality (1 percent mortality), onset slight lung injury, and onset slight gastrointestinal tract injury, since the maximum range to effects for these criteria are shorter than for PTS. Furthermore, in most cases, the predicted maximum range to PTS also consequently covers the predicted average range to TTS. Table 8 summarizes the predicted average range to TTS, average range to PTS, maximum range to PTS, and recommended mitigation zone for each activity category, based on the Navy's acoustic propagation modeling results.

The activity-specific mitigation zones are based on the longest range for all the functional hearing groups. The mitigation zone for a majority of activities is driven by either the high-frequency cetaceans or the sea turtles functional hearing groups. Therefore, the mitigation zones are even more protective for the remaining functional hearing groups (*i.e.,* low-frequency cetaceans, mid-frequency cetaceans, and pinnipeds), and likely cover a larger portion of the potential range to onset of TTS.

This evaluation includes explosive ranges to TTS and the onset of auditory injury, non-auditory injury, slight lung injury, and mortality. For every source proposed for use by the Navy, the recommended mitigation zones included in Table 8 exceed each of these ranges. In some instances, the Navy recommends mitigation zones that are larger or smaller than the predicted maximum range to PTS based on the effectiveness and operational assessments. The recommended mitigation zones and their associated assessments are provided throughout the remainder of this section. The recommended measures are either currently implemented, are modifications of current measures, or are new measures.

For some activities specified throughout the remainder of this section, Lookouts may be required to observe for concentrations of detached floating vegetation (Sargassum or kelp paddies), which are indicators of potential marine mammal presence within the mitigation zone. Those specified activities will not commence if floating vegetation (Sargassum or kelp paddies) is observed within the mitigation zone prior to the initial start of the activity. If floating vegetation is observed prior to the initial start of the activity, the activity will be relocated to an area where no floating vegetation is observed. Training will not cease as a result of indicators entering the mitigation zone after activities have commenced. This measure is intended only for floating vegetation detached from the seafloor.

TABLE 8—PREDICTED RANGES TO EFFECTS AND RECOMMENDED MITIGATION ZONES FOR EACH ACTIVITY CATEGORY

Activity category	Representative source (bin) [1]	Predicted (longest) average range to TTS	Predicted (longest) average range to PTS	Predicted maximum range to PTS	Recommended mitigation zone
Non-Impulse Sound					
Hull-Mounted Mid-Frequency Active Sonar.	SQS–53 ASW hull-mounted sonar (MF1).	3,821 yd. (3.5 km) for one ping.	100 yd. (91 m) for one ping.	Not Applicable	6 dB power down at 1,000 yd. (914 m); 4 dB power down at 500 yd. (457 m); and shutdown at 200 yd. (183 m).
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar.	AQS–22 ASW dipping sonar (MF4).	230 yd. (210 m) for one ping.	20 yd. (18 m) for one ping.	Not applicable	200 yd. (183 m).
Explosive and Impulse Sound					
Signal Underwater Sound (SUS) buoys using > 0.5–2.5 lb. NEW.	Explosive sonobuoy (E3).	290 yd. (265 m)	113 yd. (103 m)	309 yd. (283 m)	350 yd. (320 m).
Gunnery Exercises—Small- and Medium-Caliber (Surface Target).	40 mm projectile (E2)	190 yd. (174 m)	83 yd. (76 m)	182 yd. (167 m)	200 yd. (183 m).
Gunnery Exercises—Large-Caliber (Surface Target).	5 in. projectiles (E5)	453 yd. (414 m)	186 yd. (170 m)	526 yd. (481 m)	600 yd. (549 m).
Missile Exercises (Including Rockets) up to 250 lb. NEW Using a Surface Target.	Maverick missile (E9)	949 yd. (868 m)	398 yd. (364 m)	699 yd. (639 m)	900 yd. (823 m).
Missile Exercises up to 500 lb. NEW (Surface Target).	Harpoon missile (E10).	1,832 yd. (1.7 km)	731 yd. (668 m)	1,883 yd. (1.7 km)	2,000 yd. (1.8 km).
Bombing Exercises	MK–84 2,000 lb. bomb (E12).	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2,500 yd. (2.3 km)[2].
Sinking Exercises	Various up to MK–84 2,000 lb. bomb (E12).	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2.5 nm [(2)].

[1] This table does not provide an inclusive list of source bins; bins presented here represent the source bin with the largest range to effects within the given activity category.

[2] Recommended mitigation zones are larger than the modeled injury zones to account for multiple types of sources or charges being used.

Notes: in = inches, km = kilometers, lb. = pounds, m = meters, nm = nautical miles, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift, yd. = yards

Non-Impulsive Sound

Hull-Mounted Mid-Frequency Active Sonar

The Navy is proposing to (1) continue implementing the current measures for MFAS and (2) to clarify the conditions needed to recommence an activity after a marine mammal has been detected.

Activities that involve the use of hull-mounted MFA sonar will use Lookouts for visual observation from a ship immediately before and during the activity. Mitigation zones for these activities involve powering down the sonar by 6 dB when a marine mammal is sighted within 1,000 yd. (914 m) of the sonar dome, and by an additional 4 dB when sighted within 500 yd. (457 m) from the source, for a total reduction of 10 dB. Active transmissions will cease if a marine mammal is sighted within 200 yd. (183 m). Active transmission will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes, (4) the ship has transited more than 2,000 yd. (1.8 km) beyond the location of the last sighting, or (5) the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave (and there are no other marine mammal sightings within the mitigation zone). Active transmission may resume when dolphins are bow riding because they are out of the main transmission axis of the active sonar while in the shallow-wave area of the ship bow.

High-Frequency and Non-Hull-Mounted Mid-Frequency Active Sonar

Non-hull-mounted MFA sonar training activities include the use of aircraft deployed sonobuoys and helicopter dipping sonar. The Navy is proposing to: (1) Continue implementing the current mitigation measures for activities currently being executed, such as dipping sonar activities; (2) extend the implementation of its current mitigation to all other activities in this category; and (3) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft (with the exception of platforms operating at high altitudes) immediately before and during active transmission within a mitigation zone of 200 yd. (183 m) from the active sonar source. For activities involving helicopter deployed dipping sonar, visual observation will commence 10 minutes before the first deployment of active dipping sonar. Helicopter dipping and sonobuoy deployment will not begin if concentrations of floating vegetation (kelp paddies), are observed in the mitigation zone. If the source can be turned off during the activity, active transmission will cease if a marine mammal is sighted within the mitigation zone. Active transmission will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for an aircraft-deployed source, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a vessel-deployed source, (5) the vessel or aircraft has repositioned itself more than 400 yd. (370 m) away from the location of the last sighting, or (6) the vessel concludes that dolphins are deliberately closing in to ride the vessel's bow wave (and there are no other marine mammal sightings within the mitigation zone).

Explosives and Impulsive Sound

Explosive Signal Underwater Sound Buoys Using >0.5–2.5 Pound Net Explosive Weight

Mitigation measures do not currently exist for activities using explosive signal underwater sound (SUS) buoys.

The Navy is proposing to add the following recommended measures. Mitigation will include pre-exercise aerial monitoring during deployment within a mitigation zone of 350 yd. (320 m) around an explosive SUS buoy. Explosive SUS buoys will not be deployed if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone (around the intended deployment location). SUS deployment will cease if a marine mammal is sighted within the mitigation zone. Deployment will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

Passive acoustic monitoring will also be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft in order to increase vigilance of their visual surveillance.

Gunnery Exercises—Small- and Medium-Caliber Using a Surface Target

The Navy is proposing to (1) continue implementing the current mitigation measures for this activity, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) add a requirement to visually observe for kelp paddies.

Mitigation will include visual observation from a vessel or aircraft immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. Vessels will observe the mitigation zone from the firing position. When aircraft are firing, the aircrew will maintain visual watch of the mitigation zone during the activity. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing ship, or (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Gunnery Exercises—Large-Caliber Explosive Rounds Using a Surface Target

The Navy is proposing to (1) continue using the currently implemented mitigation zone measures for this activity, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) implement a requirement to visually observe for kelp paddies. The recommended measures are provided below.

Mitigation will include visual observation from a ship immediately before and during the exercise within a mitigation zone of 600 yd. (549 m) around the intended impact location. Ships will observe the mitigation zone from the firing position. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

Missile Exercises Up to 250 Pound Net Explosive Weight Using a Surface Target

Currently, the Navy employs a mitigation zone of 1,800 yd. (1.6 km) for all missile exercises. Because missiles have a wide range of warhead strength, the Navy is recommending two mitigation zones; one for missiles with warheads 250 lb. NEW and less, and a larger mitigation zone for missiles with larger warheads. The Navy is proposing to (1) modify the mitigation measures currently implemented for missile exercises involving missiles with 250 lb. NEW and smaller warheads by reducing the mitigation zone from 1,800 yd. (1.6 km) to 900 yd. (823 m). This new, reduced mitigation zone is a result of the most recent acoustic propogation modeling efforts (NAEMO) for the GOA TMAA and is based on a range to effect that is smaller than previously modeled for missile exercises using a surface target (as discussed below, the Navy is proposing to increase the mitigation zone for missiles with a NEW >250 lb.), (2) clarify the conditions needed to recommence an activity after a sighting, and (3) adopt the marine mammal mitigation zone size for floating vegetation for ease of implementation. The recommended measures are provided below.

When aircraft are involved in the missile firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 900 yd. (823 m) around the deployed target. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

Missile Exercises 251–500 Pound Net Explosive Weight (Surface Target)

Current mitigation measures apply to all missile exercises, regardless of the warhead size. The Navy proposes to add a mitigation zone that applies only to missiles with a NEW of 251 to 500 lb. The recommended measures are provided below.

When aircraft are involved in the missile firing, mitigation will include visual observation by the aircrew prior to commencement of the activity within a mitigation zone of 2,000 yd. (1.8 km) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

Bombing Exercises

Currently, the Navy employs the following mitigation zone procedures during bombing exercises:

- Ordnance shall not be targeted to impact within 1,000 yd. (914 m) of known or observed floating kelp or marine mammals.
- A 1,000 yd. (914 m) radius mitigation zone shall be established around the intended target.
- The exercise will be conducted only if marine mammals are not visible within the mitigation zone.

The Navy is proposing to (1) maintain the existing mitigation zone to be used for non-explosive bombing activities, (2) revise the mitigation zone procedures to account for predicted ranges to impacts to marine species when high explosive bombs are used, (3) clarify the conditions needed to recommence an activity after a sighting, and (4) add a requirement to visually observe for kelp paddies.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 2,500 yd. (2.3 km) around the intended impact location for explosive bombs and 1,000 yd. (920 m) for non-explosive bombs. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Bombing will cease if a marine mammal is sighted within the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

Sinking Exercises

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 2.0 nm to 2.5 nm, (2) clarify the conditions needed to recommence an activity after a sighting, (3) add a requirement to visually observe for kelp paddies, and (4) adopt the marine mammal and sea turtle mitigation zone size for concentrations of floating vegetation and aggregations of jellyfish for ease of implementation. The recommended measures are provided below.

Mitigation will include visual observation within a mitigation zone of 2.5 nm around the target ship hulk. Sinking exercises will include aerial observation beginning 90 minutes before the first firing, visual observations from vessels throughout the duration of the exercise, and both aerial and vessel observation immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours. Prior to conducting the exercise, the Navy will review remotely sensed sea surface temperature and sea surface height maps to aid in deciding where to release the target ship hulk.

The Navy will also monitor using passive acoustics during the exercise. Passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft and on vessels in order to increase vigilance of their visual surveillance. Lookouts will also increase observation vigilance before the use of torpedoes or unguided ordnance with a NEW of 500 lb. or greater, or if the Beaufort sea state is a 4 or above.

The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. The exercise will cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. The exercise will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes. Upon sinking the vessel, the Navy will conduct post-exercise visual surveillance of the mitigation zone for 2 hours (or until sunset, whichever comes first).

Weapons Firing Noise During Gunnery Exercises—Large-Caliber

The Navy currently has no mitigation zone procedures for this activity in the Study Area.

The Navy is proposing to adopt measures currently used during Navy gunnery exercises in other ranges outside of the Study Area. For all explosive and non-explosive large-caliber gunnery exercises conducted from a ship, mitigation will include visual observation immediately before and during the exercise within a mitigation zone of 70 yd. (46 m) within 30 degrees on either side of the gun target line on the firing side. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes, or (4) the vessel has repositioned itself more than 140 yd. (128 m) away from the location of the last sighting.

Physical Disturbance and Strike

Vessels

The Navy's current measures to mitigate potential impacts to marine mammals from vessel and in-water device strikes during training activities are provided below:

• Naval vessels shall maneuver to keep at least 500 yd. (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 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 would maintain normal course and speed on sighting dolphins unless some condition indicated a need for the vessel to maneuver.

The Navy is proposing to continue to use the 500 yd. (457 m) mitigation zone currently established for whales, and to implement a 200 yd. (183 m) mitigation zone for all other marine mammals. Vessels will avoid approaching marine mammals head on and will maneuver to maintain a mitigation zone of 500 yd. (457 m) around observed whales and 200 yd. (183 m) around all other marine mammals (except bow-riding dolphins), providing it is safe to do so. The Navy is clarifying its existing speed protocol; while in transit, Navy vessels shall 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 sighted object or disturbance, including any marine mammal or sea turtle, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

Towed In-Water Devices

The Navy currently has no mitigation zone procedures for this activity in the Study Area.

The Navy is proposing to adopt measures currently used in other ranges outside of the Study Area during activities involving towed in-water devices. The Navy will ensure that towed in-water devices being towed from manned platforms avoid coming within a mitigation zone of 250 yd. (229 m) around any observed marine mammal, providing it is safe to do so.

Non-Explosive Practice Munitions

Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target

Currently, the Navy employs the same mitigation measures for non-explosive gunnery exercises as described above for Gunnery Exercises—Small-, Medium-, and Large-Caliber Using a Surface Target.

The Navy is proposing to (1) continue using the mitigation measures currently implemented for this activity, and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing ship, or (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Bombing Exercises

The Navy is proposing to continue using the mitigation measures currently implemented for this activity. The recommended measure includes clarification of a post-sighting activity recommencement criterion.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 1,000 yd. (914 m) around the intended impact location. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Bombing will cease if a marine mammal is sighted within the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

Missile Exercises (Including Rockets) Using a Surface Target

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the mitigation zone from 1,800 yd. (1.6 km) to 900 yd. (823 m), (2) clarify the conditions needed to recommence an activity after a sighting, (3) adopt the marine mammal and sea turtle mitigation zone size for floating vegetation for ease of implementation, and (4) modify the platform of observation to eliminate the requirement to observe when ships are firing. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 900 yd. (823 m) around the deployed target. The exercise will not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing will cease if a marine mammal is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) The animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

Consideration of Time/Area Limitations

The Navy's and NMFS' analysis of effects to marine mammals considers emergent science regarding locations where cetaceans are known to engage in specific activities (*e.g.,* feeding, breeding/calving, or migration) at certain times of the year that are important to individual animals as well as populations of marine mammals (see discussion in Van Parijs, 2015). Where data were available, Van Parijs (2015) identified areas that are important in this way and named the areas Biologically Important Areas (BIAs). It is important to note that the BIAs were not meant to define exclusionary zones, nor were they meant to be locations that serve as sanctuaries from human activity, or areas analogous to marine protected areas (see Ferguson *et al.* (2015a) regarding the envisioned purpose for the BIA designations). The delineation of BIAs does not have direct or immediate regulatory consequences, although it is appropriate to consider them as part of the body of science that may inform mitigation decisions, depending on the circumstances. The intention was that the BIAs would serve as resource management tools and that they be considered along with any new information as well as, ''existing density estimates, range-wide distribution data, information on population trends and life history parameters, known threats to the population, and other relevant information'' (Van Parijs, 2015).

The Navy and NMFS have supported and will continue to support the Cetacean and Sound Mapping project, including representation on the Cetacean Density and distribution Working Group (CetMap), which informed NMFS' identification of BIAs. The same marine mammal density data present in the Navy's Marine Species Density Database Technical Report (U.S. Department of the Navy, 2014) and used in the analysis for the GOA SEIS/OEIS was used in the development of BIAs. The final products, including the Gulf of Alaska BIAs, from this mapping effort were completed and published in March 2015 (Aquatic Mammals, 2015; Calambokidis *et al.,* 2015; Ferguson *et al.,* 2015a, 2015b; Van Parijs, 2015). 131 BIAs for 24 marine mammal species, stocks, or populations in seven regions within U.S. waters were identified (Ferguson *et al.,* 2015a). BIAs have been identified in the Gulf of Alaska in the vicinity of the GOA TMAA Study Area and include migratory and feeding BIAs for gray whale and North Pacific right whale, respectively. However, the degree of overlap between these BIAs and the Study area is negligible geographically. NMFS' recognition of an area as biologically important for some species activity is not equivalent to designation of critical habitat under the Endangered Species Act. Furthermore, the BIAs identified by NMFS in and around the Study Area do not represent the totality of important habitat throughout the marine mammals' full range.

NMFS' Office of Protected Resources routinely considers available information about marine mammal habitat use to inform discussions with applicants regarding potential spatio-temporal limitations on their activities that might help effect the least practicable adverse impact on species or stocks and their habitat. BIAs are useful tools for planning and impact assessments and are being provided to the public via this Web site: *www.cetsound.noaa.gov.* While these BIAs are useful tools for analysts, any decisions regarding protective measures based on these areas must go through the normal MMPA evaluation process (or any other statutory process that the BIAs are used to inform); the identification of a BIA does not pre-suppose any specific management decision associated with those areas, nor does it have direct or immediate regulatory consequences. NMFS and the Navy have discussed the BIAs listed above, what Navy activities take place in these areas (in the context of what their effects on marine mammals might be or whether additional mitigation is necessary), and what measures could be implemented to reduce impacts in these areas (in the context of their potential to reduce marine mammal impacts and their practicability). An assessment of the potential spatio-temporal and activity overlap of Navy training activities with the Gulf of Alaska BIAs listed above is included below and in Chapter 3.8 of the GOA DSEIS/OEIS. In addition, in the *Group and Species-Specific Analysis* section of this proposed rule NMFS has preliminarily assessed the potential effects of Navy training on the ability of gray whale and North Pacific right whale to engage in those activities for which the BIAs have been identified (migratory and feeding). As we learn more about marine mammal density, distribution, and habitat use (and the BIAs are updated), NMFS and the Navy will continue to reevaluate appropriate time-area measures through the Adaptive Management process outlined in these regulations.

North Pacific Right Whale Feeding Area—The NMFS-identified feeding area for North Pacific right whales (see Ferguson *et al.,* 2015b) overlaps slightly with the GOA TMAA's southwestern corner. This feeding area is applicable from June to September so there is temporal overlap with the proposed Navy training but there is minimal (<1 percent) spatial overlap between this feeding area and the GOA TMAA (see Figure 3.8–2 of the GOA DSEIS/OEIS).

Given their current extremely low population numbers and the general lack of sightings in the Gulf of Alaska, the occurrence of right whales in the GOA TMAA is considered rare. North Pacific right whales have not been visually detected in the GOA TMAA since at least the 1960s. The Quinn Seamount passive acoustic detections in summer 2013 (Širović *et al.,* 2014) are the only known potential occurrence records of this species in the GOA TMAA in recent years.

Grey Whale Migratory Area—The NMFS-identified migration area for gray whales, which was bounded by the extent of the continental shelf (as provided in Ferguson *et al.,* 2015b), has slight (<1 percent) overlap with the GOA TMAA at its northernmost corner and western edge (see Ferguson *et al.,* 2015b; See Figure 3.8–4 of the GOA DSEIS/OEIS). However, this migration area is applicable only between March to May (Spring) and November to

January (Fall) (see Aquatic Mammals, 2015). This NMFS-identified gray whale migration area would not be applicable during the months when training has historically occurred (June/July) and is not likely to have temporal overlap with most of the proposed timeframe (May to October; summer) for Navy training in the GOA TMAA. It is worth mentioning that the Navy's acoustic analysis did not predict any takes of gray whales in the GOA TMAA and NMFS is not authorizing any takes of this species (see *Group and Species-Specific Analysis* section later in this proposed rule).

Potential Training Overlap with BIAs—It is very unlikely that Navy training would occur in these nearshore locations adjacent to the GOA TMAA boundary where the overlap with BIAs occurs. To ensure that the Navy is able to conduct realistic training, Navy units must maintain sufficient room to maneuver. Therefore, training activities will typically take place some distance away from an operating area boundary to ensure sufficient sea or air space is available for tactical maneuvers within an approved operating area such as the GOA TMAA. The Navy also does not typically train next to any limiting boundary because it precludes tactical consideration of the adjacent sea space and airspace beyond the boundary from being a potential threat axis during activities such as anti-submarine warfare training. It is also the case that Navy training activities will generally not be located where it is likely there would be interference from civilian vessels and aircraft that are not participating in the training activity. The nearshore boundary of the GOA TMAA is the location for multiple commercial vessel transit lanes, ship traffic, and low-altitude air routes, which all pass through the NMFS-identified feeding area and the identified migration area (see Figure 3.8–9 of the GOA DSEIS/OEIS). This level of civilian activity may otherwise conflict with Navy training activities if those Navy activities were located at that margin of the GOA TMAA and as a result such an area is generally avoided.

In short, the corners of and edge of the GOA TMAA are seldom if ever a suitable location for sustained, realistic, and coordinated training using sonar and other active acoustic sources or explosives. The Navy has lookouts and mitigation measures in place to maneuver away from and around marine mammals, and Navy vessels and aircraft are no more likely to cause any impact to these species than any other non-Navy vessels or aircraft in the area. The Navy's stand-off distance for vessels of 500 yd. (457 m) and mitigation procedures (see Proposed Mitigation) further reduce the potential that there would be any biologically meaningful effect to feeding or migration should animals be present and detected during a very unlikely Navy training event using sonar and other active acoustic sources or explosives in one of these overlapping NMFS-identified areas. Therefore, North Pacific right whales and gray whales in the NMFS-identified feeding or migration areas at these boundaries of the GOA TMAA are very unlikely to have their feeding or migration activities affected by Navy training activities using sonar and other active acoustic sources.

Conclusion—Based on the likely locations for training in the GOA TMAA, the Navy and NMFS anticipate that proposed training activities would have very limited, if any, spatial or temporal overlap with the designated North Pacific right whale area or gray whale biologically important areas. Therefore, it is unlikely that Navy training would have any biologically meaningful effect on North Pacific right whale feeding behavior or gray whale migration behavior in these areas. Moreover, appropriate mitigation measures (as detailed in Proposed Mitigation above) would be implemented for any detected marine mammals and thus further reduce the potential for the feeding or migration activities to be affected.

Stranding Response Plan

NMFS and the Navy developed a Stranding Response Plan for GOA TMAA in 2011 as part of the previous (2011–2016) incidental take authorization and rulemaking process for the Study Area. The Stranding Response Plan is specifically intended to outline the applicable requirements in the event that a marine mammal stranding is reported in the complexes during a major training exercise. NMFS considers all plausible causes within the course of a stranding investigation and this plan in no way presumes that any strandings are related to, or caused by, Navy training activities, absent a determination made during investigation. The plan is designed to address mitigation, monitoring, and compliance. The current Stranding Response Plan for the GOA TMAA is available for review at: *http://www.nmfs.noaa.gov/pr/permits/goa_tmaa_stranding_protocol.pdf*. NMFS and the Navy are currently updating the Stranding Response Plan for the GOA TMAA for 2016–2021 training activities. The updated Stranding Response Plan will be finalized prior to the release of the final rule, and will be made available for review at: *http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm#navy_goa2021*. In addition, modifications to the Stranding Response Plan may also be made through the adaptive management process.

Mitigation Conclusions

NMFS has carefully evaluated the Navy's proposed mitigation measures—many of which were developed with NMFS' input during the first phase of Navy Training authorizations—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 mitigation measures is expected to reduce the likelihood and/or magnitude of adverse impacts to marine mammal species and stocks and their habitat; the proven or likely efficacy of the measures; and the practicability of the suite of measures for applicant implementation, including consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

Based on our evaluation of the Navy's proposed measures, as well as other measures considered by NMFS, 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.

The proposed rule comment period provides 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 affect 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.

Proposed 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.

Integrated Comprehensive Monitoring Program (ICMP)

The Navy's ICMP is intended to coordinate monitoring efforts across all regions and to allocate the most appropriate level and type of effort for each range complex based on a set of standardized objectives, and in acknowledgement of regional expertise and resource availability. The ICMP is designed to be a flexible, scalable, and adaptable through the adaptive management and strategic planning processes to periodically assess progress and reevaluate objectives. Although the ICMP does not specify actual monitoring field work or projects, it does establish top-level goals that have been developed in coordination with NMFS. As the ICMP is implemented, detailed and specific studies will be developed which support the Navy's top-level monitoring goals. In essence, the ICMP directs that monitoring activities relating to the effects of Navy training and testing activities on marine species should be designed to contribute towards one or more of the following top-level goals:

- An increase in our understanding of the likely occurrence of marine mammals and/or ESA-listed marine species in the vicinity of the action (*i.e.,* presence, abundance, distribution, and/or density of species);
- An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammals and/or ESA-listed species to any of the potential stressor(s) associated with the action (*e.g.,* tonal and impulsive sound), through better understanding of one or more of the following: (1) The action and the environment in which it occurs (*e.g.,* sound source characterization, propagation, and ambient noise levels); (2) the affected species (*e.g.,* life history or dive patterns); (3) the likely co-occurrence of marine mammals and/or ESA-listed marine species with the action (in whole or part) associated with specific adverse effects, and/or; (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and/or ESA-listed marine species (*e.g.,* age class of exposed animals or known pupping, calving or feeding areas);
- An increase in our understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, *e.g.,* at what distance or received level);
- An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: (1) The long-term fitness and survival of an individual; or (2) the population, species, or stock (*e.g.,* through effects on annual rates of recruitment or survival);
- An increase in our understanding of the effectiveness of mitigation and monitoring measures;
- A better understanding and record of the manner in which the authorized entity complies with the ITA and Incidental Take Statement;
- An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals; and
- A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.

Monitoring would address the ICMP top-level goals through a collection of specific regional and ocean basin studies based on scientific objectives. Quantitative metrics of monitoring effort (*e.g.,* 20 days of aerial surveys) would not be a specific requirement. The adaptive management process and reporting requirements would serve as the basis for evaluating performance and compliance, primarily considering the quality of the work and results produced, as well as peer review and publications, and public dissemination of information, reports, and data. Details of the ICMP are available online (*http://www.navymarinespeciesmonitoring.us/*).

Strategic Planning Process for Marine Species Monitoring

The Navy also developed the Strategic Planning Process for Marine Species Monitoring, which establishes the guidelines and processes necessary to develop, evaluate, and fund individual projects based on objective scientific study questions. The process uses an underlying framework designed around top-level goals, a conceptual framework incorporating a progression of knowledge, and in consultation with a Scientific Advisory Group and other regional experts. The Strategic Planning Process for Marine Species Monitoring would be used to set intermediate scientific objectives, identify potential species of interest at a regional scale, and evaluate and select specific monitoring projects to fund or continue supporting for a given fiscal year. This process would also address relative investments to different range complexes based on goals across all range complexes, and monitoring would leverage multiple techniques for data acquisition and analysis whenever possible. The Strategic Planning Process for Marine Species Monitoring is also available online (*http://www.navymarinespeciesmonitoring.us/*).

Past and Current Monitoring in the Study Area

NMFS has received multiple years' worth of annual exercise and monitoring reports addressing active sonar use and explosive detonations within the GOA TMAA and other Navy range complexes. The data and information contained in these reports have been considered in developing mitigation and monitoring measures for the proposed training activities within the Study Area. The Navy's annual exercise and monitoring reports may be viewed at: *http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm* and *http://www.navymarinespeciesmonitoring.us.* NMFS has reviewed these reports and summarized the results, as related to marine mammal monitoring, below.

1. The Navy has shown significant initiative in developing its marine species monitoring program and made considerable progress toward reaching goals and objectives of the ICMP.

2. Observation data from watchstanders aboard navy vessels is generally useful to indicate the presence or absence of marine mammals within the mitigation zones (and sometimes beyond) and to document the implementation of mitigation measures, but does not provide useful species-specific information or behavioral data.

3. Data gathered by experienced marine mammal observers can provide very valuable information at a level of detail not possible with watchstanders.

4. Though it is by no means conclusive, it is worth noting that no instances of obvious behavioral disturbance have been observed by Navy watchstanders or experienced marine mammal observers conducting visual monitoring.

5. Visual surveys generally provide suitable data for addressing questions of distribution and abundance of marine mammals, but are much less effective at providing information on movements and behavior, with a few notable exceptions where sightings are most frequent.

6. Passive acoustics and animal tagging have significant potential for applications addressing animal movements and behavioral response to Navy training activities, but require a longer time horizon and heavy investment in analysis to produce relevant results.

7. NMFS and the Navy should more carefully consider what and how information should be gathered by watchstanders during training exercises and monitoring events, as some reports contain different information, making cross-report comparisons difficult.

This section is a summary of Navy-funded compliance monitoring in the GOA TMAA since 2011. Additional Navy-funded monitoring outside of and in addition to the Navy's commitments to NMFS is provided later in this section.

Gulf of Alaska Study Area Monitoring, 2011–2015—During the LOA development process for the 2011 GOA FEIS/OEIS, the Navy and NMFS agreed that monitoring in the Gulf of Alaska should focus on augmenting existing baseline data, since regional data on species occurrence and density are extremely limited. There have been four reports to date covering work in the Gulf of Alaska (U.S. Department of the Navy, 2011c, 2011d, 2012, 2013f). Collecting baseline data was deemed a priority prior to focusing on exercise monitoring and behavioral response as is now being done in other Navy OPAREAs and ranges. There have been no previous dedicated monitoring efforts during Navy training activities in the GOA TMAA with the exception of deployed HARPs.

In July 2011, the Navy funded deployment of two long-term bottom-mounted passive acoustic monitoring buoys by Scripps Institute of Oceanography. These HARPs were deployed southeast of Kenai Peninsula in the GOA TMAA with one on the shelf approximately 50 nm from land (in 111 fathoms [203 m] depth) and on the shelf-break slope approximately 100 nm from land (in 492 fathoms [900 m] depth). Intended to be collected annually, results from the first deployment (July 2011–May 2012) included over 5,756 hours of passive acoustic data (Baumann-Pickering *et al.* 2012b). Identification of marine mammal sounds included four baleen whale species (blue whales, fin whales, gray whales, and humpback whales) and at least six species of odontocetes (killer whale, sperm whale, Stejneger's beaked whale, Baird's beaked whale, Cuvier's beaked whale, and an unidentified porpoise presumed to be Dall's porpoise; Baumann-Pickering *et al.,* 2012b). Researchers also noted the detection of anthropogenic sound from commercial shipping. There were no Navy activities or vessels in the area at any time during the recording period.

Analysis of the passive acoustic detections made from May 2012 to June 2013 were presented in Baumann-Pickering *et al.* (2013), Debich *et al.* (2013), Debich *et al.* (2014), and the Navy's 2012, 2013, and 2014 GOA TMAA annual monitoring report submitted to NMFS (U.S. Department of the Navy, 2012, 2013f, 2014d). Three baleen whale species were detected: Blue whales, fin whales, and humpback whales. No North Pacific right whale calls were detected at either site during this monitoring period. At least seven species of odontocetes were detected: Risso's dolphins, killer whales, sperm whales, Baird's beaked whales, Cuvier's beaked whales, Stejneger's beaked whales, and unidentified porpoises (likely Dall's porpoise). Focused analysis of beaked whale echolocation recordings were presented in Baumann-Pickering *et al.* (2013).

As also presented in Debich *et al.* (2013) and U.S. Department of the Navy (2013f), broadband ship noise was found to be more common at the slope and Pratt Seamount monitoring sites within the GOA TMAA than at the nearshore (on shelf) site. Sonar (a variety of frequencies, most likely fathometers and fish-finders), were more common on the shelf and slope sites. Very few explosions were recorded at any of the three sites throughout the monitoring period. Origin of the few explosions detected are unknown, but there was no Navy explosive use in the GOA TMAA during this period, so these explosive-like events may be related to fisheries activity, lightning strikes, or some other unidentified source. There were no detections of Navy mid-frequency sonar use in the recordings (Debich *et al.* 2013, 2014; U.S. Department of the Navy 2013f, 2014d). In September 2012, an additional HARP buoy was deployed at Pratt Seamount (near the east end of the GOA TMAA) and in June 2013 two additional buoys were deployed in the GOA TMAA: One at the shelf-break near the southwest corner of the GOA TMAA and one at Quinn Seamount (the approximate middle of the GOA TMAA's southeast boundary). This constitutes a total of five Navy-funded concurrent long-term passive acoustic monitoring packages present in the GOA TMAA through fall of 2014. Debich *et al.* (2013) reported the first detection of a North Pacific right whale at the Quinn Seamount site. Over two days between June and August 2013, the Quinn seamount HARP detected three hours of North Pacific right whale calls (Debich *et al.,* 2014, Širović *et al.,* in press). Given the recording device location near the southwest border of the GOA TMAA, inability of the device as configured to determine call directionality, and likely signal propagation of several 10s of miles, it remains uncertain if the detected calls orginated within or outside of the GOA TMAA. Previous related Navy funded monitoring at multiple sites within the Study Area reported no North Pacific right whale detections (Baumann-Pickering *et al.,* 2012b, Debich *et al.,* 2013). Additional monitoring conducted in the GOA TMAA through spring 2015 included the deployment of five HARPs to detect marine mammals and anthropogenic sounds (Rice *et al.,* 2015). Future monitoring will include varying numbers of HARPs or other passive acoustic technologies based on annual Adaptive Management discussions with NMFS (see U.S. Department of the Navy [2014d] for details in that regard).

In the Gulf of Alaska, the Navy has also funded two previous marine mammal surveys to gather occurrence and density data. Although there was no regulatory requirement for the Navy to undertake either survey, the Navy funded the data collection to first support analysis of potential effects for the 2011 GOA FEIS/OEIS and again recently to support the current SEIS/OEIS. The first Navy-funded survey (GOALS) was conducted by NMFS in April 2009 (see Rone *et al.,* 2009). Line-transect survey visual data was gathered to support distance sampling statistics and acoustic data were collected over a 10-day period both within and outside the GOA TMAA. This survey resulted in sightings of several species and allowed for the derivation of densities for fin and humpback whale that supplemented multiple previous survey efforts in the vicinity (Rone *et al.,* 2009). In summer 2013, the Navy funded an additional visual line-transect survey in the offshore waters of the Gulf of Alaska (Rone *et al.,* 2014). The GOALS II survey was a 30-day visual line-transect survey supplemented by use of passive acoustics and was a follow-on effort to the previously Navy-funded GOALS survey in 2009. The primary objectives for the GOALS II survey were to acquire baseline data to increase understanding of the likely occurrence (*i.e.,* presence, abundance, distribution and/or density of species) of beaked whales and ESA-listed marine mammals in the Gulf of Alaska. Specific research objectives were:

- Assess the abundance, spatial distribution and/or density of marine mammals, with a focus on beaked whales and ESA-listed cetacean species through visual line-transect surveys and passive acoustics using a towed hydrophone array and sonobuoys
- Increase knowledge of species' vocal repertoire by linking visual sightings to vocally active cetaceans, in order to improve the effectiveness of passive acoustic monitoring
- Attempt to photo-identify and biopsy sample individual whales opportunistically for analysis of population structure, genetics and habitat use
- Attempt to locate whales for opportunistic satellite tagging using visual and passive acoustic methodology in order to provide information on both large- and fine-scale movements and habitat use of cetaceans

The Navy-funded GOALS II survey also sampled four distinct habitat areas (shelf, slope, offshore, and seamounts) which were partitioned into four strata. The survey design was intended to provide uniform coverage within the Gulf of Alaska. However, given the overall limited knowledge of beaked whales within the Gulf of Alaska, the survey was also designed to provide coverage of potential beaked whale habitat and resulted in 13 encounters with beaked whales numbering 67 individual animals (Rone *et al.,* 2014). The following additional details are summarized from the presentation in Rone *et al.* (2014). The visual survey consisted of 4,504 km (2,431 nm) of 'full-effort' and included 349 km (188 nm) of 'transit-effort.' There was an additional 375 km (202 nm) of 'fog-effort' (transect and transit). Based on total effort, there were 802 sightings (1,998 individuals) identified to species, with an additional 162 sightings (228 individuals) of unidentified cetaceans and pinnipeds. Acoustic surveying was conducted round-the-clock with a towed-hydrophone array for 6,304 km (3,997 nm) of line-transect effort totaling 426 hours of 'standard' monitoring, with an additional 374 km (202 nm) of ~30 hours of 'non-standard' and 'chase' effort. There were 379 acoustic detections and 267 localizations of 6 identified cetacean species. Additionally, 186 acoustic sonobuoys were deployed with 7 identified cetacean species detected. Two satellite transmitter tags were deployed; a tag on a blue whale (*B. musculus*) transmitted for 9 days and a tag on a Baird's beaked whale (*Berardius bairdii*) transmitted for 15 days. Based on photo-identification matches, the tagged blue whale had been previously identified off Baja California, Mexico, in 2005. Photographs of five cetacean species were collected for photo-identification purposes: fin, humpback, blue, killer (*Orcinus orca*) and Baird's beaked whales. The estimates of abundance and density for five species were obtained for the first time for the central Gulf of Alaska. Overall, the Navy funded GOALS II survey provided one of the most comprehensive datasets on marine mammal occurrence, abundance, and distribution within that rarely surveyed area (Rone *et al.,* 2014).

NMFS has acknowledged that the Navy's GOA TMAA monitoring will enhance understanding of marine mammal vocalizations and distributions within the offshore waters of the Gulf of Alaska. Additionally, NMFS pointed out that information gained from the investigations associated with the Navy's monitoring may be used in the adaptive management of monitoring measures in subsequent NMFS authorizations, if appropriate and in consultation with NMFS. The Navy is committed to structuring the Navy-sponsored research and monitoring program to address both NMFS' regulatory requirements as part of any MMPA authorizations while at the same time making significant contributions to the greater body of marine mammal science (see U.S. Department of the Navy, 2013f).

Pacific Northwest Cetacean Tagging—A Navy-funded effort in the Pacific Northwest is ongoing and involves attaching long-term satellite tracking tags to migrating gray whales off the coast of Oregon and northern California (U.S. Department of the Navy, 2013e). This study is being conducted by the University of Oregon and has also included tagging of other large whale species such as humpback whales, fin whales, and killer whales when encountered. This effort is not programmed, affiliated, or managed as part of the GOA TMAA monitoring, and is a separate regional project, but has provided information on marine mammals and their movements that has application to the Gulf of Alaska.

In one effort between May 2010 and May 2013, satellite tracking tags were placed on three gray whales, 11 fin whales, five humpback whales, and two killer whales off the Washington coast (Schorr *et al.,* 2013). One tag on an Eastern North Pacific Offshore stock killer whale, in a pod encountered off Washington at Grays Harbor Canyon, remained attached and continued to transmit for approximately 3 months. In this period, the animal transited a distance of approximately 4,700 nm, which included time spent in the nearshore margins of the TMAA in the Gulf of Alaska where it would be considered part of the Offshore stock (for stock designations, see Muto and Angliss, 2015). In a second effort between 2012 and 2013, tags were attached to 11 Pacific Coast Feeding Group gray whales near Crescent City, California; in general, the tag-reported positions indicated these whales were moving southward at this time of year (Mate, 2013). The Navy's 2013 annual monitoring report for the Northwest Training and Testing Range contains the details of the findings from both research efforts described above (U.S. Department of the Navy, 2013e).

Proposed Monitoring for the GOA TMAA Study Area

Based on NMFS-Navy meetings in June and October 2011, and the upcoming annual monitoring meeting scheduled for March 2016, future Navy compliance monitoring, including ongoing monitoring, will address ICMP top-level goals through a series of regional and ocean basin study questions with a prioritization and funding focus on species of interest as identified for each range complex. The ICMP will also address relative investments to different range complexes based on goals across all range complexes, and monitoring will leverage multiple techniques for data acquisition and analysis whenever possible.

Within the GOA TMAA Study Area, the Navy's monitoring for GOA TMAA under this LOA authorization and concurrently in other areas of the Pacific Ocean will therefore be structured to address region-specific species-specific study questions in consultation with NMFS.

The outcome of the March 2016 Navy-NMFS monitoring meeting, including any proposed monitoring during the period covered by this proposed rule

(2016–2021) will be discussed in the final rule. In addition, Navy monitoring projects proposed during the 2016–2021 GOA TMAA rulemaking period will be posted on the Navy's marine species monitoring Web site (*http://www.navymarinespeciesmonitoring.us/regions/pacific/current-projects/*).

Ongoing Navy Research

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities on the marine environment including marine mammals. From 2004 through 2013, the Navy has funded over $240M specifically for marine mammal research. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. It is imperative that the Navy's R&D efforts related to marine mammals are conducted in an open, transparent manner with validated study needs and requirements. The goal of the Navy's R&D program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Historically, R&D programs are funded and developed by the Navy's Chief of Naval Operations Energy and Environmental Readiness Division (OPNAV N45) and Office of Naval Research (ONR), Code 322 Marine Mammals and Biological Oceanography Program. The primary focus of these programs since the 1990s is on understanding the effects of sound on marine mammals, including physiological, behavioral, and ecological effects.

ONR's current Marine Mammals and Biology Program thrusts include, but are not limited to: (1) monitoring and detection research, (2) integrated ecosystem research including sensor and tag development, (3) effects of sound on marine life (such as hearing, behavioral response studies, physiology [diving and stress], and PCAD), and (4) models and databases for environmental compliance.

To manage some of the Navy's marine mammal research programmatic elements, OPNAV N45 developed in 2011 a new Living Marine Resources (LMR) Research and Development Program (*http://www.lmr.navy.mil/*). The goal of the LMR Research and Development Program is to identify and fill knowledge gaps and to demonstrate, validate, and integrate new processes and technologies to minimize potential effects to marine mammals and other marine resources. Key elements of the LMR program include:

- Providing science-based information to support Navy environmental effects assessments for research, development, acquisition, testing and evaluation as well as Fleet at-sea training, exercises, maintenance and support activities.
- Improving knowledge of the status and trends of marine species of concern and the ecosystems of which they are a part.
- Developing the scientific basis for the criteria and thresholds to measure the effects of Navy generated sound.
- Improving understanding of underwater sound and sound field characterization unique to assessing the biological consequences resulting from underwater sound (as opposed to tactical applications of underwater sound or propagation loss modeling for military communications or tactical applications).
- Developing technologies and methods to monitor and, where possible, mitigate biologically significant consequences to living marine resources resulting from naval activities, emphasizing those consequences that are most likely to be biologically significant.

Navy Research and Development

Navy Funded—Both the LMR and ONR Research and Development Programs periodically fund projects within the Study Area. Some data and results, when available from these R&D projects, are typically summarized in the Navy's annual range complex Monitoring Reports that are currently submitted to the NMFS each year. In addition, the Navy's Range Complex monitoring during training and testing activities is coordinated with the R&D monitoring in a given region to leverage research objectives, assets, and studies where possible under the ICMP.

The integration between the Navy's new LMR Research and Development Program and related range complex monitoring will continue and improve during this LOA application period with applicable results presented in GOA TMAA annual monitoring reports.

Other National Department of Defense Funded Initiatives—Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) are the DoD's environmental research programs, harnessing the latest science and technology to improve environmental performance, reduce costs, and enhance and sustain mission capabilities. The Programs respond to environmental technology requirements that are common to all of the military Services, complementing the Services' research programs. SERDP and ESTCP promote partnerships and collaboration among academia, industry, the military Services, and other Federal agencies. They are independent programs managed from a joint office to coordinate the full spectrum of efforts, from basic and applied research to field demonstration and validation.

Adaptive Management

The final regulations governing the take of marine mammals incidental to Navy training activities in the Study Area would contain an adaptive management component carried over from previous authorizations. Although better than 5 years ago, our understanding of the effects of Navy training and testing activities (*e.g.,* MFAS/HFAS, underwater detonations) on marine mammals is still relatively limited, 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.

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 whether any changes are appropriate. NMFS and the Navy would meet to discuss the monitoring reports, Navy R&D developments, and current science and whether mitigation or monitoring modifications are appropriate. The use of adaptive management allows 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). Mitigation measures could be modified if new data suggests that such modifications would have a reasonable likelihood of reducing adverse effects to marine mammals and if the measures are practicable.

The following are some of the possible sources of applicable data to be considered through the adaptive management process: (1) Results from monitoring and exercises reports, as required by MMPA authorizations; (2) compiled results of Navy funded R&D

studies; (3) results from specific stranding investigations; (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 LOA.

Proposed 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. Some of the reporting requirements are still in development and the final rulemaking may contain additional details not contained here. Additionally, proposed reporting requirements may be modified, removed, or added based on information or comments received during the public comment period. Reports from individual monitoring events, results of analyses, publications, and periodic progress reports for specific monitoring projects would be posted to the Navy's Marine Species Monitoring web portal: *http://www.navymarinespeciesmonitoring.us*. Currently, there are several different reporting requirements pursuant to these proposed regulations:

General Notification of Injured or Dead Marine Mammals

Navy personnel would ensure that NMFS (the appropriate Regional Stranding Coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. The Navy would provide NMFS with species identification or a 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 photographs or video (if available). The Navy shall consult the Stranding Response Plan to obtain more specific reporting requirements for specific circumstances.

Vessel Strike

NMFS has developed the following language to address monitoring and reporting measures specific to vessel strike. Most of this language comes directly from the Stranding Response Plan for other Navy training and testing rulemakings. This section has also been included in the regulatory text at the end of this proposed rule. Vessel strike during Navy training activities in the Study Area is not anticipated; however, in the event that a Navy vessel strikes a whale, the Navy shall do the following:

Immediately report to NMFS (pursuant to the established Communication Protocol) the:

- Species identification (if known);
- Location (latitude/longitude) of the animal (or location of the strike if the animal has disappeared);
- Whether the animal is alive or dead (or unknown); and
- The time of the strike.

As soon as feasible, the Navy shall report to or provide to NMFS, the:

- Size, length, and description (critical if species is not known) of animal;
- An estimate of the injury status (*e.g.,* dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared, etc.);
- Description of the behavior of the whale during event, immediately after the strike, and following the strike (until the report is made or the animal is no longer sighted);
- Vessel class/type and operational status;
- Vessel length;
- Vessel speed and heading; and
- To the best extent possible, obtain a photo or video of the struck animal, if the animal is still in view.

Within 2 weeks of the strike, provide NMFS:

- A detailed description of the specific actions of the vessel in the 30-minute timeframe immediately preceding the strike, during the event, and immediately after the strike (*e.g.,* the speed and changes in speed, the direction and changes in direction, other maneuvers, sonar use, etc., if not classified);
- A narrative description of marine mammal sightings during the event and immediately after, and any information as to sightings prior to the strike, if available; and use established Navy shipboard procedures to make a camera available to attempt to capture photographs following a ship strike.

NMFS and the Navy will coordinate to determine the services the Navy may provide to assist NMFS with the investigation of the strike. The response and support activities to be provided by the Navy are dependent on resource availability, must be consistent with military security, and must be logistically feasible without compromising Navy personnel safety. Assistance requested and provided may vary based on distance of strike from shore, the nature of the vessel that hit the whale, available nearby Navy resources, operational and installation commitments, or other factors.

Annual GOA TMAA Monitoring Report

The Navy shall submit an annual report of the GOA TMAA monitoring describing the implementation and results from the previous calendar year. Data collection methods will be standardized across range complexes and study areas to allow for comparison in different geographic locations. Although additional information will be gathered, Navy Lookouts collecting marine mammal data pursuant to the GOA TMAA monitoring plan shall, at a minimum, provide the same marine mammal observation data required in § 218.155. The report shall be submitted either 90 days after the calendar year, or 90 days after the conclusion of the monitoring year to be determined by the Adaptive Management process. The GOA TMAA Monitoring Report may be provided to NMFS within a larger report that includes the required Monitoring Plan reports from multiple range complexes and study areas (the multi-Range Complex Annual Monitoring Report). Such a report would describe progress of knowledge made with respect to monitoring plan study questions across all Navy ranges associated with the Integrated Comprehensive Monitoring Program. Similar study questions shall be treated together so that progress on each topic shall be summarized across all Navy ranges. The report need not include analyses and content that does not provide direct assessment of cumulative progress on the monitoring plan study questions.

Annual GOA TMAA Exercise Report

Each year, the Navy shall submit a preliminary report detailing the status of authorized sound sources within 21 days after the anniversary of the date of issuance of the LOA. Each year, the Navy shall submit a detailed report within 3 months after the anniversary of the date of issuance of the LOA. The annual report shall contain information on Major Training Exercises (MTEs), Sinking Exercise (SINKEX) events, and a summary of all sound sources used (total hours or quantity [per the LOA] of each bin of sonar or other non-impulsive source; total annual number of each type of explosive exercises; and total annual expended/detonated rounds [missiles, bombs, sonobuoys, etc.] for each explosive bin). The analysis in the detailed report will be based on the accumulation of data from the current year's report and data collected from previous the report. Information included in the classified annual reports may be used to inform future adaptive management of activities within the GOA TMAA.

Sonar Exercise Notification

The Navy shall submit to NMFS (specific contact information to be provided in LOA) an electronic report within fifteen calendar days after the completion of any major training exercise indicating: Location of the exercise; beginning and end dates of the exercise; and type of exercise.

5-Year Close-Out Exercise Report

This report will be included as part of the 2021 annual exercise report. This report will provide the annual totals for each sound source bin with a comparison to the annual allowance and the 5-year total for each sound source bin with a comparison to the 5-year allowance. Additionally, if there were any changes to the sound source allowance, this report will include a discussion of why the change was made and include the analysis to support how the change did or did not result in a change in the SEIS and final rule determinations. The report will be submitted 3 months after the expiration of the rule. NMFS will submit comments on the draft close-out report, if any, within 3 months of receipt. The report will be considered final after the Navy has addressed NMFS' comments, or 3 months after the submittal of the draft if NMFS does not provide comments.

Estimated Take of Marine Mammals

In the Potential Effects section, NMFS' analysis identified the lethal responses, physical trauma, sensory impairment (PTS, TTS, and acoustic masking), physiological responses (particular stress responses), and behavioral responses that could potentially result from exposure to MFAS/HFAS or underwater explosive detonations. In this section, the potential effects to marine mammals from MFAS/HFAS and underwater detonation of explosives will be related to the MMPA regulatory definitions of Level A and Level B harassment and we will attempt to quantify the effects that might occur from the proposed training activities in the Study Area.

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, 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 sometimes contribute 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].'' It is important to note that, as Level B harassment is interpreted here and quantified by the behavioral thresholds described below, the fact that a single behavioral pattern (of unspecified duration) is abandoned or significantly altered and classified as a Level B take does not mean, necessarily, that the fitness of the harassed individual is affected either at all or significantly, or that, for example, a preferred habitat area is abandoned. Further analysis of context and duration of likely exposures and effects is necessary to determine the impacts of the estimated effects on individuals and how those may translate to population level impacts, and is included in the Analysis and Negligible Impact Determination.

Level B Harassment

Of the potential effects that were described earlier in this proposed rule, 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 non-impulsive or impulsive sound, is considered Level B harassment. Some of the lower level physiological stress responses discussed earlier would 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. Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data. Responses can overlap; for example, an increased respiration rate is likely to be coupled to a flight response or other avoidance behavior. Factors to consider when trying to predict a stress response include the mammal's life history stage and whether they are naïve or experienced with the sound. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf, 2001; Bejder *et al.,* 2009).

As the statutory definition is currently applied, a wide range of behavioral reactions may qualify as Level B harassment under the MMPA, including but not limited to avoidance of the sound source, temporary changes in vocalizations or dive patters, temporary avoidance of an area, or temporary disruption of feeding, migrating, or reproductive behaviors. The estimates calculated by the Navy using the acoustic thresholds do not differentiate between the different types of potential behavioral reactions. Nor do the estimates provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. We therefore consider the available scientific evidence to determine the likely nature of the modeled behavioral responses and the potential fitness consequences for affected individuals.

Acoustic Masking and Communication Impairment—Acoustic masking and communication impairment are considered Level B harassment as they can disrupt natural behavioral patterns by interrupting or limiting the marine mammal's receipt or transmittal of important information or environmental cues. As discussed in the Analysis and Negligible Impact Determination later in this proposed rule, 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, communication series, or other critical auditory cue, 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. The other sources used in Navy training, many of either higher frequencies (meaning that the sounds generated attenuate even closer to the source) or lower amounts of operation, are similarly not expected to result in masking or communication impairment.

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

The sound characteristics that correlate with specific stress responses in marine mammals are poorly understood. Therefore, in practice, a stress response is assumed if a physiological reaction such as a hearing loss (threshold shift—*i.e.,* TTS or PTS) or trauma is predicted (or if a behavioral response is predicted, as discussed in the *Level B Harassment* section).

Only non-TTS behavioral reactions and TTS are anticipated with the GOA TMAA training activities, and these Level B behavioral harassment takes are enumerated in Tables 12 and 13 and in the Negligible Impact Determination later in this proposed rule.

Level A Harassment

Of the potential effects that were described earlier, following are the types of effects that can fall into the Level A harassment category (unless they further rise to the level of serious injury or mortality):

Permanent Threshold Shift (PTS)—PTS (resulting either from 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. As mentioned above for TTS, a stress response is assumed if a physiological reaction such as a hearing loss (PTS) or trauma is predicted.

As discussed in the Negligible Impact Determination later in this proposed rule, only a small number (5) of Level A takes resulting from mild levels of PTS are predicted, and no serious injury or mortality takes are predicted, with the Navy's training activities in the GOA TMAA.

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 which could cause tissue damage that would be considered injurious. A short duration of 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. For the reasons above, Level A harassment in the form of tissue damage from acoustically mediated bubble growth is not predicted for training activities in the GOA TMAA.

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 (unusually rapid ascent, unusually long series of surface dives, etc.) in a manner that might result in unusual bubble formation or growth ultimately resulting in tissue damage. 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 traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.,* 2003; Fernandez *et al.,* 2005; Fernández *et al.,* 2012), 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. Recent modeling by Kvadsheim *et al.* (2012) determined that while behavioral and physiological responses to sonar have the potential to result in bubble formation, the actual observed behavioral responses of cetaceans to sonar did not imply any significantly increased risk over what may otherwise occur normally in individual marine mammals. Level A harassment in the form of tissue damage from behaviorally mediated bubble growth is not anticipated for training activities in the GOA TMAA.

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. Explosions in the ocean or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds are likely within the audible range of most marine mammals, but the duration of individual sounds is very short. The direct sound from explosions used during training activities last less than a second, and most events involve the use of only one or a few explosions. Furthermore, events are dispersed in time and throughout the GOA TMAA Study Area. These factors reduce the likelihood of these sources causing substantial physical disruption of tissues in marine mammals, especially when the avoidance and mitigation factors are taken into consideration. Consequently, no Level A harassment from explosive shock waves is anticipated from training activities in the GOA TMAA.

Vessel or Ordnance Strike—Vessel strike or ordnance strike associated with the specified activities would be considered Level A harassment, serious injury, or mortality. There are no records of any Navy vessel strikes to marine mammals during training activities in the GOA TMMA Study Area. There have been Navy strikes of large whales in areas outside the Study Area, such as Hawaii and Southern California. However, these areas differ significantly from the Study Area given that both Hawaii and Southern California have a much higher number of Navy vessel activities and much higher densities of large whales. The Navy's proposed actions would not result in any appreciable changes in locations or frequency of vessel activity, and there have been no whale strikes during any previous training activities in the Study Area. The manner in which the Navy has trained would remain consistent with the range of variability observed over the last decade so the Navy does not anticipate vessel strikes would occur within the Study Area during training events. As such, vessel or ordnance strike is not anticipated with the Navy activities in the Study Area and Level A harassment, serious injury, or mortality are not expected.

Take Thresholds

For the purposes of an MMPA 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 non-impulse and impulse sounds cannot be easily detected or measured, 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 thresholds that estimate at what received level (when exposed to non-impulse or impulse sounds) Level B harassment and Level A harassment of marine mammals would occur. The acoustic thresholds for non-impulse and impulse sounds are discussed below.

Level B Harassment Threshold (TTS)—Behavioral disturbance, acoustic masking, and TTS are all considered Level B harassment. Marine mammals would usually be behaviorally disturbed at lower received levels than those at which they would likely sustain TTS, so the levels at which behavioral disturbance are likely to occur is considered the onset of Level B harassment. The behavioral responses of marine mammals to sound are variable, context specific, and, therefore, difficult to quantify (see Risk Function section, below).

TTS is a physiological effect that has been studied and quantified in laboratory conditions. Because data exist to support an estimate of the received levels at which marine mammals will incur TTS, NMFS uses an acoustic criteria to estimate the number of marine mammals that might sustain TTS. TTS is a subset of Level B harassment (along with sub-TTS behavioral harassment) and the Navy is not specifically required to estimate those numbers; however, the more specifically the affected marine mammal responses can be estimated, the better the analysis.

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 determined through study of terrestrial mammals.

We note here that behaviorally mediated injuries (such as those that have been hypothesized as the cause of some beaked whale strandings) could potentially occur in response to received levels lower than those believed to directly result in tissue damage. As mentioned previously, data to support a quantitative estimate of these potential effects (for which the exact mechanism is not known and in which factors other than received level may play a significant role) do not exist. However, based on the number of years (more than 60) and number of hours of MFAS per year that the U.S. (and other countries) has operated compared to the reported (and verified) cases of associated marine mammal strandings, NMFS believes that the probability of these types of injuries is very low. Tables 9 and 10 provide a summary of non-impulsive and impulsive thresholds to TTS and PTS for marine mammals. A detailed explanation of how these thresholds were derived is provided in the Criteria and Thresholds Technical Report (Finneran and Jenkins, 2012) and summarized in Chapter 6 of the LOA application (*http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm*).

TABLE 9—ONSET TTS AND PTS THRESHOLDS FOR NON-IMPULSE SOUND

Group	Species	Onset TTS	Onset PTS
Low-Frequency Cetaceans	All mysticetes	178 dB re 1µPa2-sec(LF_{II})	198 dB re 1µPa2-sec(LF_{II}).
Mid-Frequency Cetaceans	Most delphinids, beaked whales, medium and large toothed whales.	178 dB re 1µPa2-sec(MF_{II})	198 dB re 1µPa2-sec(MF_{II}).
High-Frequency Cetaceans	Porpoises, *Kogia* spp.	152 dB re 1µPa2-sec(HF_{II})	172 dB re 1µPa2-secSEL (HF_{II}).
Phocidae In-water	Harbor, Hawaiian monk, elephant seals.	183 dB re 1µPa2-sec(P_{WI})	197 dB re 1µPa2-sec(P_{WI}).

TABLE 9—ONSET TTS AND PTS THRESHOLDS FOR NON-IMPULSE SOUND—Continued

Group	Species	Onset TTS	Onset PTS
Otariidae & Obodenidae In-water ..	Sea lions and fur seals	206 dB re 1µPa2-sec(O_{WI})	220 dB re 1µPa2-sec(O_{WI}).
Mustelidae In-water	Sea otters.		

LF_{II}, MF_{II}, HF_{II}: New compound Type II weighting functions; P_{WI}, O_{WI}: Original Type I (Southall *et al.,* 2007) for pinniped and mustelid in water.

Table 10. Impulsive sound explosive criteria and thresholds for predicting injury and mortality.

<table>
<tr><th>Group</th><th>Species</th><th>Onset TTS</th><th>Onset PTS</th><th>Onset Slight GI Tract Injury</th><th>Onset Slight Lung Injury</th><th>Onset Mortality</th></tr>
<tr><td>Low Frequency Cetaceans</td><td>All mysticetes</td><td>172 dB re 1 µPa²-s SEL (Type II weighting) or 224 dB re 1 µPa Peak SPL (unweighted)</td><td>187 dB re 1 µPa²-s SEL (Type II weighting) or 230 dB re 1 µPa Peak SPL (unweighted)</td><td rowspan="6">237 dB re 1 µPa (unweighted)</td><td rowspan="6">Note 1</td><td rowspan="6">Note 2</td></tr>
<tr><td>Mid-Frequency Cetaceans</td><td>Most delphinids, medium and large toothed whales</td><td>172 dB re 1 µPa²-s SEL (Type II weighting) or 224 dB re 1 µPa Peak SPL (unweighted)</td><td>187 dB re 1 µPa²-s SEL (Type II weighting) or 230 dB re 1 µPa Peak SPL (unweighted)</td></tr>
<tr><td>High Frequency Cetaceans</td><td>Porpoises and Kogia spp.</td><td>146 dB re 1 µPa²-s SEL (Type II weighting) or 195 dB re 1 µPa Peak SPL (unweighted)</td><td>161 dB re 1 µPa²-s SEL (Type II weighting) or 201 dB re 1 µPa Peak SPL (unweighted)</td></tr>
<tr><td>Phocidae</td><td>Northern elephant seal and harbor seal</td><td>177 dB re 1 µPa²-s (Type I weighting) or 212 dB re 1 µPa Peak SPL (unweighted)</td><td>192 dB re 1 µPa²-s (Type I weighting) or 218 dB re 1 µPa Peak SPL (unweighted)</td></tr>
<tr><td>Otariidae</td><td>Steller and California Sea Lion, Guadalupe and Northern fur seal</td><td rowspan="2">200 dB re 1 µPa²-s (Type I weighting) or 212 dB re 1 µPa Peak SPL (unweighted)</td><td rowspan="2">215 dB re 1 µPa²-s (Type I weighting) or 218 dB re 1 µPa Peak SPL (unweighted)</td></tr>
<tr><td>Mustelidae</td><td>Sea Otter</td></tr>
<tr><td colspan="3">Note 1 $= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-\sec$</td><td colspan="4">Note 2 $= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-\sec$</td></tr>
</table>

[1] Impulse calculated over a delivery time that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for animal size and depth.

Notes: GI = gastrointestinal, M = mass of animals in kilograms, D_{Rm} = depth of receiver (animal) in meters, SEL = Sound Exposure Level, SPL = Sound Pressure Level (re 1 µPa), dB = decibels, re 1 µPa = referenced to one micropascal, dB re 1 µPa²-s = decibels referenced to one micropascal squared second

Level B Harassment Risk Function (Behavioral Harassment)

As the statutory definition is currently applied, a wide range of behavioral reactions may qualify as Level B harassment under the MMPA, including but not limited to avoidance of the sound source, temporary changes in vocalizations or dive patters, temporary avoidance of an area, or temporary disruption of feeding, migrating, or reproductive behaviors. The estimates calculated by the Navy using the acoustic thresholds do not differentiate between the different types of potential behavioral reactions. Nor do the estimates provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. We therefore consider the available scientific evidence to determine the likely nature of the modeled behavioral responses and the potential fitness consequences for affected individuals.

Behavioral Response Criteria for Non-Impulsive Sound from Sonar and other Active Sources—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 173 dB SEL would not be taken by Level B harassment. As mentioned previously, marine mammal behavioral responses to sound are highly variable and context specific (affected by differences in acoustic conditions; differences between species and populations; differences in gender, age, reproductive status, or social behavior; or the prior experience of the individuals), which means that there is support for alternate approaches for estimating behavioral harassment.

Unlike step functions, acoustic risk continuum functions (which are also called ''exposure-response functions'' or ''dose-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. In January 2009, NMFS issued three final rules governing the incidental take of marine mammals (within Navy's Hawaii Range, Southern California Training and Testing Range, and Atlantic Fleet Active Sonar Training complexes) 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 Surveillance Towed Array Sensor System Low Frequency Active (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 earlier, factors other than received level (such as distance from or bearing to the sound source, context of animal at time of exposure) can affect the way that marine mammals respond; however, data to support a quantitative analysis of those (and other factors) do not currently exist. It is also worth specifically noting that while context is very important in marine mammal response, given otherwise equivalent context, the severity of a marine mammal behavioral response is also expected to increase with received level (Houser and Moore, 2014). NMFS will continue to modify these criteria as new data become available and can be appropriately and effectively incorporated.

The particular acoustic risk functions developed by NMFS and the Navy (see Figures 1 and 2 of the LOA application) 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)

Detailed information on the above equation and its parameters is available in the LOA application and previous Navy documents listed above.

The harbor porpoise and beaked whales have unique criteria based on specific data that show these animals to be especially sensitive to sound. Harbor porpoise and beaked whale non-impulsive behavioral criteria are used unweighted—without weighting the received level before comparing it to the threshold (see Finneran and Jenkins, 2012).

It has been speculated for some time that beaked whales might have unusual sensitivities to sonar sound due to their likelihood of stranding in conjunction with mid-frequency sonar use, even in areas where other species were more abundant (D'Amico *et al.,* 2009), but there were not sufficient data to support a separate treatment for beaked whales until recently. With the recent publication of results from Blainville's beaked whale monitoring and experimental exposure studies on the instrumented AUTEC range in the Bahamas (McCarthy *et al.* 2011; Tyack *et al.* 2011), there are now statistically strong data suggesting that beaked whales tend to avoid actual naval mid-frequency sonar in real anti-submarine training scenarios as well as playbacks of killer whale vocalizations, and other anthropogenic sounds. Tyack *et al.* (2011) report that, in reaction to sonar playbacks, most beaked whales stopped echolocating, made long slow ascent, and moved away from the sound. During an exercise using mid-frequency sonar, beaked whales avoided the sonar acoustic footprint at a distance where the received level was ''around 140 dB'' (SPL) and once the exercise ended, beaked whales re-inhabited the center of exercise area within 2–3 days (Tyack *et al.,* 2011). The Navy has therefore adopted an unweighted 140 dB re 1 µPa SPL threshold for significant behavioral effects for all beaked whales (family: Ziphiidae).

Since the development of the criterion, analysis of the data the 2010 and 2011 field seasons of the southern California Behavioral Responses Study have been published. The study, DeRuiter *et al.* (2013b), provides similar evidence of Cuvier's beaked whale sensitivities to sound based on two controlled exposures. Two whales, one in each season, were tagged and exposed to simulated mid-frequency active sonar at distances of 3.4–9.5 km. The 2011 whale was also incidentally exposed to mid-frequency active sonar from a distant naval exercise (approximately 118 km away). Received levels from the mid-frequency active sonar signals during the controlled and incidental exposures were calculated as

84–144 and 78–106 dB re 1 μPa rms, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (*e.g.,* source proximity, controlled source ramp-up) may have been a significant factor. Because the sample size was limited (controlled exposures during a single dive in both 2010 and 2011) and baseline behavioral data was obtained from different stocks and geographic areas (*i.e.,* Hawaii and Mediterranean Sea), and the responses exhibited to controlled exposures were not exhibited by an animal exposed to some of the same received levels of real sonar exercises, the Navy relied on the studies at the AUTEC that analyzed beaked whale responses to actual naval exercises using mid-frequency active sonar to evaluate potential behavioral responses by beaked whales to proposed training and testing activities using sonar and other active acoustic sources.

The information currently available regarding harbor porpoises suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein *et al.,* 2000; Kastelein *et al.,* 2005; Kastelein *et al.,* 2006; Kastelein *et al.,* 2008) and wild harbor porpoises (Johnston, 2002) responded to sound (*e.g.,* acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) are very low (*e.g.,* approximately 120 dB re 1 μPa). Therefore, a SPL of 120 dB re 1 μPa is used in this analysis as a threshold for predicting behavioral responses in harbor porpoises instead of the risk functions used for other species (*i.e.,* we assume for the purpose of estimating take that all harbor porpoises exposed to 120 dB or higher MFAS/HFAS will be taken by Level B behavioral harassment).

Behavioral Response Criteria for Impulsive Sound from Explosions — If more than one explosive event occurs within any given 24-hour period within a training or testing event, behavioral criteria are applied to predict the number of animals that may be taken by Level B harassment. For multiple explosive events the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold (in sound exposure level). This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulse TTS testing (Schlundt *et al.,* 2000). Some multiple explosive events, such as certain naval gunnery exercises, may be treated as a single impulsive event because a few explosions occur closely spaced within a very short period of time (a few seconds). For single impulses at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response. Since no further sounds follow the initial brief impulses, Level B take in the form of behavioral harassment beyond that associated with potential TTS would not be expected to occur. This reasoning was applied to previous shock trials (63 FR 230; 66 FR 87; 73 FR 143) and is extended to these Phase 2 criteria. Behavioral thresholds for impulsive sources are summarized in Table 11 and further detailed in the LOA application.

Since impulse events can be quite short, it may be possible to accumulate multiple received impulses at sound pressure levels considerably above the energy-based criterion and still not be considered a behavioral take. The Navy treats all individual received impulses as if they were one second long for the purposes of calculating cumulative sound exposure level for multiple impulse events. For example, five air gun impulses, each 0.1 second long, received at a Type II weighted sound pressure level of 167 dB SPL would equal a 164 dB sound exposure level, and would not be predicted as leading to a significant behavioral response (take) in MF or HF cetaceans. However, if the five 0.1 second pulses are treated as a 5 second exposure, it would yield an adjusted SEL of approximately 169 dB, exceeding the behavioral threshold of 167 dB SEL. For impulses associated with explosions that have durations of a few microseconds, this assumption greatly overestimates effects based on sound exposure level metrics such as TTS and PTS and behavioral responses. Appropriate weighting values will be applied to the received impulse in one-third octave bands and the energy summed to produce a total weighted sound exposure level value. For impulsive behavioral criteria, the Navy's weighting functions (detailed in Chapter 6 of the LOA application) are applied to the received sound level before being compared to the threshold.

TABLE 11—BEHAVIORAL THRESHOLDS FOR IMPULSIVE SOUND

Hearing group	Impulsive behavioral threshold for > 2 pulses/24 hours	Onset TTS
Low-Frequency Cetaceans	167 dB SEL (LF_{II})	172 dB SEL (MF_{II}) or 224 dB Peak SPL.
Mid-Frequency Cetaceans	167 dB SEL (MF_{II}).	
High-Frequency Cetaceans	141 dB SEL (HF_{II})	146 dB SEL (HF_{II}) or 195 dB Peak SPL.
Phocid Seals (in water)	172 dB SEL (P_{WI})	177 dB SEL (P_{WI}) or 212 dB Peak SPL.
Otariidae & Mustelidae (in water)	195 dB SEL (O_{WI})	200 dB SEL (O_{WI}) or 212 dB Peak SPL.

Notes: (1) LF_{II}, MF_{II}, HF_{II} are New compound Type II weighting functions; P_{WI}, O_{WI} = Original Type I (Southall *et al.,* 2007) for pinniped and mustelid in water (see Finneran and Jenkins 2012). (2) SEL = re 1 $\mu Pa^2 - s$; SPL = re 1 μPa, SEL = Sound Exposure Level, dB = decibel, SPL = Sound Pressure Level.

Marine Mammal Density Estimates

A quantitative impact analysis requires an estimate of the number of animals that might be affected by anthropogenic activities. A key element of this estimation is knowledge of the abundance and concentration of the species in specific areas where those activities will occur. The most appropriate unit of metric for this type of analysis is animal density, or the number of animals present per unit area. Marine species density estimation requires a significant amount of effort to both collect and analyze data to produce a reasonable estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, and are not easily observed. In order to collect enough sighting data to make reasonable density estimates, multiple observations are required, often in areas that are not easily accessible (*e.g.,* far offshore). Ideally, marine species sighting data would be collected for the specific area and time period (*e.g.,* season) of interest and density estimates derived accordingly. However, in many places, poor weather conditions and high sea states prohibit the completion of comprehensive visual surveys.

For most cetacean species, abundance is estimated using line-transect surveys or mark-recapture studies (*e.g.,* Barlow, 2010, Barlow and Forney, 2007, Calambokidis *et al.,* 2008). The result provides one single density estimate value for each species across broad geographic areas, such as waters within the U.S. EEZ off California, Oregon, and Washington. This is the general approach applied in estimating cetacean abundance in the NMFS Stock Assessment Reports. Although the single value provides a good average estimate of abundance (total number of individuals) for a specified area, it does not provide information on the species distribution or concentrations within that area, and it does not estimate density for other timeframes or seasons that were not surveyed. More recently, habitat modeling has been used to estimate cetacean densities (Barlow *et al.,* 2009; Becker *et al.,* 2010, 2012a, b, c; Ferguson *et al.,* 2006a; Forney *et al.,* 2012; Redfern *et al.,* 2006). These models estimate cetacean density as a continuous function of habitat variables (*e.g.,* sea surface temperature, seafloor depth, etc.) and thus allow predictions of cetacean densities on finer spatial scales than traditional line-transect or mark-recapture analyses. Within the geographic area that was modeled, densities can be predicted wherever these habitat variables can be measured or estimated.

Uncertainty in published density estimates is typically large because of the low number of sightings available for their derivation. Uncertainty is typically expressed by the coefficient of variation (CV) of the estimate, which is derived using standard statistical methods and describes the amount of variation with respect to the population mean. It is expressed as a fraction or sometimes a percentage and can range upward from zero, indicating no uncertainty, to high values. For example, a CV of 0.85 would indicate high uncertainty in the population estimate. When the CV exceeds 1.0, the estimate is very uncertain. The uncertainty associated with movements of animals into or out of an area (due to factors such as availability of prey or changing oceanographic conditions) is much larger than is indicated by the CV.

The methods used to estimate pinniped at-sea densities are typically different than those used for cetaceans. This is discussed in more detail in the Navy Marine Species Density Database Technical Report (U.S. Department of the Navy, 2014). Pinniped abundance is generally estimated via shore counts of animals at known rookeries and haulout sites. Translating these numbers to in-water densities is difficult given the variability in foraging ranges, migration, and haulout behavior between species and within each species, and is driven by factors such as age class, sex class, seasonal variation, etc. Details of the density derivation for each species of pinniped in the Study Area are provided in the U.S. Department of the Navy (2014). In summary, the methods used to derive pinniped densities involved a series of species-specific data reviews to compile the most accurate and up-to-date information available. The total abundance divided by the area of the region was the resultant density estimate for each species in a given location.

There is no single source of density data for every area, marine mammal species, and season because of the fiscal costs, resources, and effort involved to provide enough survey coverage to sufficiently estimate density. NMFS Southwest Fisheries Science Center conducts standard U.S. West Coast surveys every 5–6 years and cannot logistically support more frequent studies. The U.S. Navy has funded two previous marine mammal surveys in the GOA TMAA (Rone *et al.,* 2009, 2014) in the summer time-period when Navy training activities are most likely to occur. The density data used to quantitatively estimate impacts to marine mammals from Navy training in the GOA TMAA are based on the best available science and were agreed upon with NMFS as a cooperating agency for the SEIS/OEIS. As the federal regulator for the MMPA, the NMFS role included having staff biologists review and comment on the analysis and the SEIS/OEIS. The review also included coordination with NMFS regional scientists from the Southwest Fisheries Science Center and Alaska Fisheries Science Center on the latest emergent data presented in their Pacific Stock Assessment Reports.

In May 2015, the Marine Mammal Commission also reviewed the Marine Species Density Database Technical Report (U.S. Department of the Navy, 2014) and pointed out some textual errors that the Navy subsequently corrected, but otherwise did not identify any changes in the data used for acoustic effects modeling.

A certain number of sightings are required to generate the quality of data necessary to produce either traditional line-transect density estimates or spatial habitat modeled density values. The at-sea identification of some species of specific MMPA designated stocks is not always possible from available field data, nor would additional data collection likely address the identification issue based on low animal occurrence (*e.g.,* Western North Pacific gray whale), cryptic behaviors (*e.g.,* beaked whales), and appearance similarities between stocks (*e.g.,* Steller sea lions). In the absence of species-specific population survey data for these species, density estimates are derived from different methods and data sources, based on NMFS recommendations. The different methods for each of these species are described in Section 3.8.3.1.6.1 (Marine Species Density Data) of the DSEIS/OEIS and the Marine Species Density Database Technical Report (U.S. Department of the Navy, 2014). NMFS and Navy have determined that these alternative density estimates are sufficient for determining the impacts of Navy training on these marine mammals under all applicable statutes, and therefore are the best available science.

Therefore, to characterize marine mammal density for areas of concern, including the GOA TMAA Study Area, the Navy compiled data from multiple sources. Each data source may use different methods to estimate density and uncertainty (*e.g.,* variance) associated with the estimates.

The Navy thus developed a protocol to select the best available data sources based on species, area, and time (season). The Navy then used this protocol to identify the best density data from available sources, including habitat-based density models, line-transect analyses, and peer-reviewed published studies. These data were incorporated into a Geographic Information System database that includes seasonal (summer/fall and winter/spring) density values for every marine mammal species present within the Study Area. Detailed information on the Navy's selection protocol, datasets, and specific density values are provided in the Navy Marine Species Density Database Technical Report (U.S. Department of the Navy, 2014).

Quantitative Modeling To Estimate Take for Impulsive and Non-Impulsive Sound

The Navy performed a quantitative analysis to estimate the number of marine mammals that could be affected by acoustic sources or explosives used during Navy training activities. Inputs to the quantitative analysis include marine mammal density estimates; marine mammal depth occurrence distributions; oceanographic and environmental data; marine mammal hearing data; and criteria and thresholds for levels of potential effects. The quantitative analysis consists of computer modeled estimates and a post-model analysis to determine the number of potential mortalities and harassments. The model calculates sound energy propagation from sonar, other active acoustic sources, and explosives during naval activities; the sound or impulse received by animat (virtual representation of an animal) dosimeters representing marine mammals distributed in the area around the modeled activity; and whether the sound or impulse received by a marine mammal exceeds the thresholds for effects. The model estimates are then further analyzed to consider animal avoidance and implementation of mitigation measures, resulting in final estimates of potential effects due to Navy training.

Various computer models and mathematical equations can be used to predict how energy spreads from a sound source (*e.g.,* sonar or underwater detonation) to a receiver (*e.g.,* dolphin or sea turtle). Basic underwater sound models calculate the overlap of energy and marine life using assumptions that account for the many, variable, and often unknown factors that can influence the result. Assumptions in previous and current Navy models have intentionally erred on the side of overestimation when there are unknowns or when the addition of other variables was not likely to substantively change the final analysis. For example, because the ocean environment is extremely dynamic and information is often limited to a synthesis of data gathered over wide areas and requiring many years of research, known information tends to be an average of a seasonal or annual variation. El Niño Southern Oscillation events of the ocean-atmosphere system are an example of dynamic change where unusually warm or cold ocean temperatures are likely to redistribute marine life and alter the propagation of underwater sound energy. Previous Navy modeling therefore made some assumptions indicative of a maximum theoretical propagation for sound energy (such as a perfectly reflective ocean surface and a flat seafloor).

More complex computer models build upon basic modeling by factoring in additional variables in an effort to be more accurate by accounting for such things as variable bathymetry and an animal's likely presence at various depths.

The Navy has developed new software tools, up to date marine mammal density data, and other oceanographic data for the quantification of estimated acoustic impacts to marine mammal impacts from Navy activities. This new approach is the resulting evolution of the basic model previously used by the Navy and reflects a more complex modeling approach as described below. The new model, NAEMO, is the standard model now used by the navy to estimate the potential acoustic effects of Navy training and testing activities on marine mammals. Although this more complex computer modeling approach accounts for various environmental factors affecting acoustic propagation, the current software tools do not consider the likelihood that a marine mammal would attempt to avoid repeated exposures to a sound or avoid an area of intense activity where a training or testing event may be focused. Additionally, the software tools do not consider the implementation of mitigation (*e.g.,* stopping sonar transmissions when a marine mammal is within a certain distance of a ship or mitigation zone clearance prior to detonations). In both of these situations, naval activities are modeled as though an activity would occur regardless of proximity to marine mammals and without any horizontal movement by the animal away from the sound source or human activities. Therefore, the final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures. This final, post-analysis step in the modeling process is meant to better quantify the predicted effects by accounting for likely animal avoidance behavior and implementation of standard Navy mitigations.

The incorporation of mitigation factors for the reduction of predicted effects used a conservative approach (erring on the side of overestimating the number of effects) since reductions as a result of implemented mitigation were only applied to those events having a very high likelihood of detecting marine mammals.

The steps of the quantitative analysis of acoustic effects, the values and assumptions that went into the Navy's model, and the resulting ranges to effects are detailed in Chapter 6 (Section 6.5) of the LOA application (*http://www.nmfs.noaa.gov/pr/permits/incidental/*). Details of the model's processes and the description and derivation of the inputs are presented in the Navy's Determination of Acoustic Effects technical Report (Marine Species Modeling Team, 2014). The post-model analysis, which considers the potential for avoidance and highly effective mitigation during the use of sonar and other active acoustic sources and explosives, is described in Section 6.5 of the LOA application. A detailed explanation of the post-model acoustic effect analysis quantification process is also provided in the technical report Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for the Gulf of Alaska Training (U.S. Department of the Navy, 2014c; also available at: *http://goaeis.com/Documents/SupplementalEISOEISDocumentsandReferences/SupportingTechnicalDocuments.aspx*).

Take Request

The GOA DSEIS/OEIS considered all training activities proposed to occur in the Study Area that have the potential to result in the MMPA defined take of marine mammals. The stressors associated with these activities included the following:

- Acoustic (sonar and other active non-impulse sources, explosives, swimmer defense airguns, weapons firing, launch and impact noise, vessel noise, aircraft noise);
- Energy (electromagnetic devices);
- Physical disturbance or strikes (vessels, in-water devices, military expended materials, seafloor devices);
- Entanglement (fiber optic cables, guidance wires, parachutes);
- Ingestion (munitions, military expended materials other than munitions); and
- Secondary stressors (sediments and water quality).

The Navy determined, and NMFS agrees, that two stressors could potentially result in the incidental taking of marine mammals from training activities within the Study Area: (1) Non-impulsive stressors (sonar and other active acoustic sources) and (2) impulsive stressors (explosives). Non-impulsive and impulsive stressors have the potential to result in incidental takes of marine mammals by harassment, injury, or mortality.

Training Activities

A detailed analysis of effects due to marine mammal exposures to impulsive and non-impulsive sources in the Study Area is presented in Chapter 6 of the LOA application. Based on the model and post-model analysis described in Chapter 6 of the LOA application, Table 12 summarizes the Navy's final take request for training activities for a year (up to 2 exercises occurring over a 7-month period [April–October]) and the summation over a 5-year period (up to 2 exercises occurring over a 7-month period [April–October] for a total of 10 exercises).

TABLE 12—SUMMARY OF ANNUAL AND 5-YEAR TAKE REQUESTS FOR GOA TMAA TRAINING ACTIVITIES

MMPA Category	Source	Training activities	
		Annual authorization sought	5-Year authorization sought
Mortality	Explosives	0	0.
Level A	Sonar and other active acoustic sources; explosives.	5 (Dall's porpoise only as shown in Table 13).	25 (Dall's porpoise only as shown in Table 13).
Level B	Sonar and other active acoustic sources; explosives.	36,522 (Species specific data shown in Table 13).	182,610 (Species specific data shown in Table 13).

Impulsive and Non-Impulsive Sources

Table 13 provides details on the Navy's final take request for training activities by species from the acoustic effects modeling estimates. Derivations of the numbers presented in Table 13 are described in more detail within Chapter 6 of the LOA application. Level A effects are only predicted to occur for Dall's porpoises. There are no mortalities predicted for any of the proposed training activities.

TABLE 13—SPECIES-SPECIFIC TAKE REQUESTS FROM MODELING ESTIMATES OF IMPULSIVE AND NON-IMPULSIVE SOURCE EFFECTS FOR ALL TRAINING ACTIVITIES

Species	Stock	Annual		5-Year	
		Level B	Level A	Level B	Level A
North Pacific right whale	Eastern North Pacific	7	0	35	0
Humpback whale	Central North Pacific	129	0	645	0
	Western North Pacific	10	0	50	0
Blue whale	Eastern North Pacific	95	0	475	0
	Central North Pacific	0	0	0	0
Fin whale	Northeast Pacific	2,582	0	12,910	0
Sei whale	Eastern North Pacific	13	0	65	0
Minke whale	Alaska	87	0	435	0
Gray whale	Eastern North Pacific	0	0	0	0
	Western North Pacific	0	0	0	0
Sperm whale	North Pacific	197	0	985	0
Killer whale	Alaska Resident	564	0	2,820	0
	Eastern North Pacific Offshore	53	0	265	0
	AT1 Transient	1	0	5	0
	GOA, Aleutian Island, and Bearing Sea Transient.	144	0	720	0
Pacific white-sided dolphin	North Pacific	1,963	0	9,815	0
Harbor porpoise	Gulf of Alaska	5,484	0	27,420	0
	Southeast Alaska	1,926	0	9,630	0
Dall's porpoise	Alaska	16,244	5	81,220	25
Cuvier's beaked whale	Alaska	2,544	0	12,720	0
Baird's beaked whale	Alaska	401	0	2,005	0
Stejneger's beaked whale	Alaska	1,153	0	5,765	0
Steller sea lion	Eastern U.S.	671	0	3,355	0
	Western U.S.	572	0	2,860	0
California sea lion	U.S.	5	0	25	0
Northern fur seal	Eastern Pacific-Alaska	1,428	0	7,140	0
Northern elephant seal	California Breeding	245	0	1,225	0
Harbor seal	Aleutian Islands	0	0	0	0
	Pribilof Islands	0	0	0	0
	Bristol Bay	0	0	0	0
	North Kodiak	1	0	5	0
	South Kodiak	1	0	5	0
	Prince William Sound	2	0	10	0
	Cook Inlet/Shelikof	0	0	0	0
	Glacier Bay/Icy Strait	0	0	0	0
	Lynn Canal/Stephens	0	0	0	0
Harbor seal	Sitka/Chatham	0	0	0	0
	Dixon/Cape Decision	0	0	0	0
	Clarence Strait	0	0	0	0
Ribbon seal	Alaska	0	0	0	0
Totals		36,522	5	182,610	25

Marine Mammal Habitat

The Navy's proposed training activities could potentially affect marine mammal habitat through the introduction of sound into the water column, impacts to the prey species of marine mammals, bottom disturbance, or changes in water quality. Each of these components was considered in the

GOA DSEIS/OEIS and was determined by the Navy to have no effect on marine mammal habitat. Based on the information below and the supporting information included in the GOA DSEIS/OEIS, NMFS has preliminarily determined that the proposed training activities would not have adverse or long-term impacts on marine mammal habitat.

Expected Effects on 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. Acoustic exposures are not expected to result in long-term physical alteration of the water column or bottom topography, as the occurrences are of limited duration and are intermittent in time. Surface vessels associated with the activities are present in limited duration and are intermittent as they move relatively rapidly through any given area. Most of the high-explosive military expended materials would detonate at or near the water surface. Only bottom-laid explosives are likely to affect bottom substrate; habitat used for underwater detonations and seafloor device placement would primarily be soft-bottom sediment. Once on the seafloor, military expended material would likely be colonized by benthic organisms because the materials would serve as anchor points in the shifting bottom substrates, similar to a reef. The surface area of bottom substrate affected would make up a very small percentage of the total training area available in the Study Area.

Effects on Marine Mammal Prey

Invertebrates—Marine invertebrate distribution in the Study Area is influenced by habitat, ocean currents, and water quality factors such as temperature, salinity, and nutrient content (Levinton 2009). The distribution of invertebrates is also influenced by their distance from the equator (latitude); in general, the number of marine invertebrate species increases toward the equator (Macpherson 2002). The higher number of species (diversity) and abundance of marine invertebrates in coastal habitats, compared with the open ocean, is a result of more nutrient availability from terrestrial environments and the variety of habitats and substrates found in coastal waters (Levinton 2009).

The GOA is one of the world's most productive ocean regions and the habitats associated with these cold and turbulent waters contain identifiable collections of macrohabitats that sustain a multitude of invertebrate species. Invertebrates in the GOA provide valuable links in the food chain and perform ecosystem functions such as nutrient processing. For humans, invertebrates contribute to economic, cultural, and recreational activities in the GOA.

All marine invertebrate taxonomic groups are represented in the Study Area. Major invertebrate phyla and the general zones they inhabit in the Study Area are described in Chapter 3 of the 2011 GOA FEIS/OEIS.

Very little is known about sound detection and use of sound by aquatic invertebrates (Budelmann 2010; Montgomery *et al.,* 2006; Popper *et al.,* 2001). Organisms may detect sound by sensing either the particle motion or pressure component of sound, or both. Aquatic invertebrates probably do not detect pressure since many are generally the same density as water and few, if any, have air cavities that would function like the fish swim bladder in responding to pressure (Budelmann, 2010; Popper *et al.,* 2001). Many marine invertebrates, however, have ciliated ''hair'' cells that may be sensitive to water movements, such as those caused by currents or water particle motion very close to a sound source (Budelmann, 2010; Mackie and Singla, 2003). These cilia may allow invertebrates to sense nearby prey or predators or help with local navigation. Marine invertebrates may produce and use sound in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Popper *et al.,* 2001).

Both behavioral and auditory brainstem response studies suggest that crustaceans may sense sounds up to three kilohertz (kHz), but best sensitivity is likely below 200 Hz (Lovell *et al.,* 2005; Lovell *et al.,* 2006; Goodall *et al.,* 1990). Most cephalopods (*e.g.,* octopus and squid) likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies (Budelmann, 2010; Mooney *et al.,* 2010; Packard *et al.,* 1990). A few cephalopods may sense higher frequencies up to 1,500 Hz (Hu *et al.,* 2009). Squid did not respond to toothed whale ultrasonic echolocation clicks at sound pressure levels ranging from 199 to 226 dB re 1 μPa peak-to-peak, likely because these clicks were outside of squid hearing range (Wilson *et al.,* 2007). However, squid exhibited alarm responses when exposed to broadband sound from an approaching seismic airgun with received levels exceeding 145 to 150 dB re 1 μPa root mean square (McCauley *et al.,* 2000b).

Little information is available on the potential impacts on marine invertebrates of exposure to sonar, explosions, and other sound-producing activities. It is expected that most marine invertebrates would not sense mid- or high-frequency sounds, distant sounds, or aircraft noise transmitted through the air-water interface. Most marine invertebrates would not be close enough to intense sound sources, such as some sonars, to potentially experience impacts to sensory structures. Any marine invertebrate capable of sensing sound may alter its behavior if exposed to non-impulsive sound, although it is unknown if responses to non-impulsive sounds occur. Continuous noise, such as from vessels, may contribute to masking of relevant environmental sounds, such as reef noise. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and vessels would be in transit, any sound exposures with the potential to cause masking or behavioral responses would be brief and long-term impacts are not expected. Although non-impulsive underwater sounds produced during training activities may briefly impact individuals, intermittent exposures to non-impulsive sounds are not expected to impact survival, growth, recruitment, or reproduction of widespread marine invertebrate populations.

Detonations associated with the Navy's GOA TMAA activities would occur well offshore (the middle of the GOA TMAA is 140 nm offshore; except for a point near Cape Cleare on Montague Island [12 nm away], the nearest shoreline [Kenai Peninsula] is 24 nm north of the GOA TMAA northern boundary). As water depth increases away from shore, benthic invertebrates would be less likely to be impacted by detonations at or near the surface. In addition, detonations near the surface would release a portion of their explosive energy into the air, reducing the explosive impacts in the water. Some marine invertebrates may be sensitive to the low-frequency component of impulsive sound, and they may exhibit startle reactions or temporary changes in swim speed in response to an impulsive exposure. Because exposures are brief, limited in number, and spread over a large area, no long-term impacts due to startle reactions or short-term behavioral changes are expected. Although individual marine invertebrates may be injured or killed during an explosion or pile driving, no long-term impacts on the survival, growth, recruitment, or reproduction of marine invertebrate populations are expected.

Fish—Fish are not distributed uniformly throughout the Study Area, but are closely associated with a variety of habitats. Some species range across thousands of square miles while others have small home ranges and restricted distributions (Helfman *et al.,* 2009). The movements of some open-ocean species may never overlap with coastal fishes that spend their lives within several hundred feet (a few hundred meters) of the shore. Even within a single fish species, the distribution and specific habitats in which individuals occur may be influenced by its developmental stage, size, sex, reproductive condition, and other factors.

The distribution and abundance of fishes depends greatly on the physical and biological factors of the marine ecosystem, such as salinity, temperature, dissolved oxygen, population dynamics, predator and prey interaction oscillations, seasonal movements, reproduction and life cycles, and recruitment success (Helfman *et al.,* 1997). A single factor is rarely responsible for the distribution of fish species; more often, a combination of factors is accountable. For example, open ocean species optimize their growth, reproduction, and survival by tracking gradients of temperature, oxygen, or salinity (Helfman *et al.,* 1997). Another major component in understanding species distribution is the location of highly productive regions, such as frontal zones. These areas concentrate various prey species and their predators, such as tuna, and provide visual cues for the location of target species for commercial fisheries (NMFS, 2001).

At least 383 species belonging to 84 families of marine and anadromous fishes have been reported from the predominant ecosystems found in the GOA TMAA. Detailed information on taxa presence, distribution, and characteristics are provided in Chapter 3 of the 2011 GOA FEIS/OEIS.

All fish have two sensory systems to detect sound in the water: The inner ear, which functions very much like the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the fish's body (Popper, 2008). The inner ear generally detects relatively higher-frequency sounds, while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper, 2005a). Although hearing capability data only exist for fewer than 100 of the 32,000 fish species, current data suggest that most species of fish detect sounds from 50 to 1,000 Hz, with few fish hearing sounds above 4 kHz (Popper, 2008). It is believed that most fish have their best hearing sensitivity from 100 to 400 Hz (Popper, 2003b). Additionally, some clupeids (shad in the subfamily Alosinae) possess ultrasonic hearing (*i.e.,* able to detect sounds above 100,000 Hz) (Astrup, 1999). Permanent hearing loss, or permanent threshold shift has not been documented in fish. The sensory hair cells of the inner ear in fish can regenerate after they are damaged, unlike in mammals where sensory hair cells loss is permanent (Lombarte *et al.,* 1993; Smith *et al.,* 2006). As a consequence, any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (*e.g.,* Smith *et al.,* 2006).

Potential direct injuries from non-impulsive sound sources, such as sonar, are unlikely because of the relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives. Non-impulsive sources also lack the strong shock waves associated with an explosion. Therefore, direct injury is not likely to occur from exposure to non-impulsive sources such as sonar, vessel noise, or subsonic aircraft noise. Only a few fish species are able to detect high-frequency sonar and could have behavioral reactions or experience auditory masking during these activities. These effects are expected to be transient and long-term consequences for the population are not expected. MFAS is unlikely to impact fish species because most species are unable to detect sounds in this frequency range and vessels operating MFAS would be transiting an area (not stationary). While a large number of fish species may be able to detect low-frequency sonar and other active acoustic sources, low-frequency active usage is rare and mostly conducted in deeper waters. Overall effects to fish from non-impulsive sound sources would be localized and infrequent.

Physical effects from pressure waves generated by underwater sounds (*e.g.* underwater explosions) could potentially affect fish within proximity of training activities. In particular, the rapid oscillation between high- and low-pressure peaks has the potential to burst the swim bladders and other gas-containing organs of fish (Keevin and Hemen, 1997). Sublethal effects, such as changes in behavior of fish, have been observed in several occasions as a result of noise produced by explosives (National Research Council of the National Academies, 2003; Wright, 1982). If an individual fish were repeatedly exposed to sounds from underwater explosions that caused alterations in natural behavioral patterns or physiological stress, these impacts could lead to long-term consequences for the individual such as reduced survival, growth, or reproductive capacity. However, the time scale of individual explosions is very limited, and training exercises involving explosions are dispersed in space and time. Consequently, repeated exposure of individual fish to sounds from underwater explosions is not likely and most acoustic effects are expected to be short-term and localized. Long-term consequences for populations would not be expected.

Marine Mammal Avoidance

Marine mammals may be temporarily displaced from areas where Navy training is occurring, but the area should be utilized again after the activities have ceased. Avoidance of an area can help the animal avoid further acoustic effects by avoiding or reducing further exposure. The intermittent or short duration of many activities should prevent animals from being exposed to stressors on a continuous basis (for the GOA TMAA, training activities will not occur continuously throughout the year, but rather, for a maximum of 21 days either once or twice annually). In areas of repeated and frequent acoustic disturbance, some animals may habituate or learn to tolerate the new baseline or fluctuations in noise level. While some animals may not return to an area, or may begin using an area differently due to training activities, most animals are expected to return to their usual locations and behavior.

Other Expected Effects

Other sources that may affect marine mammal habitat were considered in the GOA DSEIS/OEIS and potentially include the introduction of fuel, debris, ordnance, and chemical residues into the water column. The majority of high-order explosions would occur at or above the surface of the ocean, and would have no impacts on sediments and minimal impacts on water quality. While disturbance or strike from an item falling through the water column is possible, it is unlikely because (1) objects sink slowly, (2) most projectiles are fired at targets (and hit those targets), and (3) animals are generally widely dispersed throughout the water column and over the Study Area. Chemical, physical, or biological changes in sediment or water quality would not be detectable. In the event of an ordnance failure, the energetic materials it contained would remain mostly intact. The explosive materials in failed ordnance items and metal components from training would leach slowly and would quickly disperse in the water column. Chemicals from other explosives would not be introduced into the water column in large amounts and all torpedoes would be recovered following training activities, reducing the potential for chemical concentrations to reach levels that can affect sediment quality, water quality, or benthic habitats.

Preliminary Analysis and Negligible Impact Determination

Negligible impact is ''an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival'' (50 CFR 216.103). 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 takes, alone, is not enough information on which to base an impact determination, as the severity of harassment may vary greatly depending on the context and duration of the behavioral response, many of which would not be expected to have deleterious impacts on the fitness of any individuals. In determining whether the expected takes will have a negligible impact, in addition to considering estimates of the number of marine mammals that might be ''taken,'' 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 (*e.g.,* severity) of estimated Level A harassment takes, the number of estimated mortalities, and the status of the species. As a reminder, the GOA TMAA training activities will not occur continuously throughout the year, but rather, for a maximum of 21 days either once or twice annually).

The Navy's specified activities have been described based on best estimates of the maximum amount of sonar and other acoustic source use or detonations that the Navy would conduct. There may be some flexibility in that the exact number of hours, items, or detonations may vary from year to year, but take totals are not authorized to exceed the 5-year totals indicated in Tables 12–13. We base our analysis and NID on the maximum number of takes authorized, although, as stated before, the number of takes are only a part of the analysis, which includes extensive qualitative consideration of other contextual factors that influence the degree of impact of the takes on the effected individuals. To avoid repetition, we provide some general analysis immediately below that applies to all the species listed in Tables 13, given that some of the anticipated effects (or lack thereof) of the Navy's training activities on marine mammals are expected to be relatively similar in nature. However, below that, we break our analysis into species, or groups of species where relevant similarities exist, to provide more specific information related to the anticipated effects on individuals or where there is information about the status or structure of any species that would lead to a differing assessment of the effects on the population.

The Navy's take request is based on its model and post-model analysis. In the discussions below, the ''acoustic analysis'' refers to the Navy's modeling results and post-model analysis. The model calculates sound energy propagation from sonar, other active acoustic sources, and explosives during naval activities; the sound or impulse received by animat dosimeters representing marine mammals distributed in the area around the modeled activity; and whether the sound or impulse received by a marine mammal exceeds the thresholds for effects. The model estimates are then further analyzed to consider animal avoidance and implementation of highly effective mitigation measures to prevent Level A harassment, resulting in final estimates of effects due to Navy training and testing. NMFS provided input to the Navy on this process and the Navy's qualitative analysis is described in detail in Chapter 6 of its LOA application (*http://www.nmfs.noaa.gov/pr/permits/incidental/militry.htm*).

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 requested number of Level B takes does not equate to the number of individual animals the Navy expects to harass (which is lower), but rather to the instances of take (*i.e.,* exposures above the Level B harassment threshold) that would occur. Additionally, these instances may represent either a very brief exposure (seconds) or, in some cases, longer durations of exposure within a day. Depending on the location, duration, and frequency of activities, along with the distribution and movement of marine mammals, individual animals may be exposed to impulse or non-impulse sounds at or above the Level B harassment threshold on multiple days. However, the Navy is currently unable to estimate the number of individuals that may be taken during training and testing activities. The model results estimate the total number of takes that may occur to a smaller number of individuals. While the model shows that an increased number of exposures may take place due to an increase in events/activities and ordnance, the types and severity of individual responses to training and testing activities are not expected to change.

Behavioral Harassment

As discussed previously in this proposed rule, marine mammals can respond to LF/MFAS/HFAS in many different ways, a subset of which qualifies as behavioral harassment. As described in the proposed rule, the Navy uses the behavioral response function to quantify the number of behavioral responses that would qualify as Level B behavioral harassment under the MMPA. As the statutory definition is currently applied, a wide range of behavioral reactions may qualify as Level B harassment under the MMPA, including but not limited to avoidance of the sound source, temporary changes in vocalizations or dive patterns, temporary avoidance of an area, or temporary disruption of feeding, migrating, or reproductive behaviors.

Some of the lower level physiological stress responses discussed earlier would 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. Level B takes, then, may have a stress-related physiological component as well; however, we would not expect the Navy's generally short-term, intermittent, and (in the case of sonar) transitory activities to create conditions of long-term, continuous noise leading to long-term physiological stress responses in marine mammals.

The estimates calculated using the behavioral response function do not differentiate between the different types of potential reactions. Nor do the estimates provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. We therefore consider the available scientific evidence to determine the likely nature of the modeled behavioral responses and the potential fitness consequences for affected individuals.

For LF/MFAS/HFAS use in the GOA TMAA, the Navy provided information (Table 14) estimating the percentage of behavioral harassment that would occur within the 6–dB bins (without considering mitigation or avoidance). 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. As illustrated below, the majority (including about 72 percent for the most powerful ASW hull-mounted sonar, which is responsible for a large portion of the sonar takes) of calculated takes from MFAS result from exposures less than 156 dB. Less than 1 percent of the takes are expected to result from exposures above 174 dB. Specifically, given a range of behavioral responses that may be classified as Level B harassment, to the degree that higher received levels are expected to result in more severe behavioral responses, only a small percentage of the anticipated Level B harassment from Navy activities might necessarily be expected to potentially result in more severe responses, especially when the distance from the source at which the levels below are received is considered (see Table 14). Marine mammals are able to discern the distance of a given sound source, and given other equal factors (including received level), they have been reported to respond more to sounds that are closer (DeRuiter *et al.,* 2013). Further, the estimated number of responses do not reflect either the duration or context of those anticipated responses, some of which will be of very short duration, and other factors should be considered when predicting how the estimated takes may affect individual fitness. A recent study by Moore and Barlow (2013) emphasizes the importance of context (*e.g.,* behavioral state of the animals, distance from the sound source, etc.) in evaluating behavioral responses of marine mammals to acoustic sources.

TABLE 14—NON-IMPULSIVE RANGES IN 6-dB BINS AND PERCENTAGE OF BEHAVIORAL HARASSMENTS

Received level	Sonar bin MF1 (e.g., SQS–53; ASW hull mounted sonar)		Sonar bin MF4 (e.g., AQS–22; ASW dipping sonar)		Sonar Bin MF5 (e.g., SSQ–62; ASW sonobuoy)	
	Distance at which levels occur within radius of source (m)	Percentage of behavioral harassments occurring at given levels	Distance at which levels occur within radius of source (m)	Percentage of behavioral harassments occurring at given levels	Distance at which levels occur within radius of source (m)	Percentage of behavioral harassments occurring at given levels
Low Frequency Cetaceans						
120 ≤ SPL <126	178,750–156,450	0.00	100,000–92,200	0.00	22,800–15,650	0.00
126 ≤ SPL <132	156,450–147,500	0.00	92,200–55,050	0.11	15,650–11,850	0.05
132 ≤ SPL <138	147,500–103,700	0.21	55,050–46,550	1.08	11,850–6,950	2.84
138 ≤ SPL <144	103,700–97,950	0.33	46,550–15,150	35.69	6,950–3,600	16.04
144 ≤ SPL <150	97,950–55,050	13.73	15,150–5,900	26.40	3,600–1,700	33.63
150 ≤ SPL <156	55,050–49,900	5.28	5,900–2,700	17.43	1,700–250	44.12
156 ≤ SPL <162	49,900–10,700	72.62	2,700–1,500	9.99	250–100	2.56
162 ≤ SPL <168	10,700–4,200	6.13	1,500–200	9.07	100–<50	0.76
168 ≤ SPL <174	4,200–1,850	1.32	200–100	0.18	<50	0.00
174 ≤ SPL <180	1,850–850	0.30	100–<50	0.05	<50	0.00
180 ≤ SPL <186	850–400	0.07	<50	0.00	<50	0.00
186 ≤ SPL <192	400–200	0.01	<50	0.00	<50	0.00
192 ≤ SPL <198	200–100	0.00	<50	0.00	<50	0.00
Mid Frequency Cetaceans						
120 ≤ SPL <126	179,400–156,450	0.00	100,000–92,200	0.00	23,413–16,125	0.00
126 ≤ SPL <132	156,450–147,500	0.00	92,200–55,050	0.11	16,125–11,500	0.06
132 ≤ SPL <138	147,500–103,750	0.21	55,050–46,550	1.08	11,500–6,738	2.56
138 ≤ SPL <144	103,750–97,950	0.33	46,550–15,150	35.69	6,738–3,825	13.35
144 ≤ SPL <150	97,950–55,900	13.36	15,150–5,900	26.40	3,825–1,713	37.37
150 ≤ SPL <156	55,900–49,900	6.12	5,900–2,700	17.43	1,713–250	42.85
156 ≤ SPL <162	49,900–11,450	71.18	2,700–1,500	9.99	250–150	1.87
162 ≤ SPL <168	11,450–4,350	7.01	1,500–200	9.07	150–<50	1.93
168 ≤ SPL <174	4,350–1,850	1.42	200–100	0.18	<50	0.00
174 ≤ SPL <180	1,850–850	0.29	100–<50	0.05	<50	0.00
180 ≤ SPL <186	850–400	0.07	<50	0.00	<50	0.00
186 ≤ SPL <192	400–200	0.01	<50	0.00	<50	0.00
192 ≤ SPL <198	200–100	0.00	<50	0.00	<50	0.00

Notes: (1) ASW = anti-submarine warfare, m = meters, SPL = sound pressure level; (2) Odontocete behavioral response function is also used for high-frequency cetaceans, phocid seals, otariid seals and sea lions, and sea otters.

Although the Navy has been monitoring to discern the effects of LF/MFAS/HFAS on marine mammals since 2006, and research on the effects of MFAS is advancing, our understanding of exactly how marine mammals in the Study Area will respond to LF/MFAS/HFAS is still improving. The Navy has submitted more than 80 reports, including Major Exercise Reports, Annual Exercise Reports, and Monitoring Reports, documenting hundreds of thousands of marine mammals across Navy range complexes, and there are only two instances of overt behavioral disturbances that have been 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.), the full series of behaviors that would more accurately show an important change is not typically seen (*i.e.,* only the surface behaviors are observed), 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.

Diel Cycle

As noted previously, many animals perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hour 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). Note that there is a difference between multiple-day substantive behavioral reactions and multiple-day anthropogenic activities. For example, just because an at-sea exercise lasts for multiple days does not necessarily mean that individual animals are either exposed to those exercises for multiple days or, further, exposed in a manner resulting in a sustained multiple day substantive behavioral response. Large multi-day Navy exercises, such as those proposed in the GOA TMAA, typically include vessels that are continuously moving at speeds typically 10–15 knots, or higher, and likely cover large areas that are relatively far from shore, in addition to the fact that marine mammals are moving as well, 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. Additionally, the Navy does not necessarily operate active sonar the entire time during an exercise. While it is certainly possible that these sorts of exercises could overlap with individual marine mammals multiple days in a row at levels above those anticipated to result in a take, because of the factors mentioned above, it is considered unlikely for the majority of takes. It does not mean that a behavioral response is necessarily sustained for multiple days, but instead necessitates the consideration of likely duration and context to assess any effects on the individual's fitness.

Durations for non-impulsive activities utilizing tactical sonar sources vary and are fully described in Appendix A of the GOA DSEIS/OEIS. ASW training exercises using MFAS/HFAS proposed for the GOA TMAA generally last for 2–16 hours, and may have intervals of non-activity in between. Because of the need to train in a large variety of situations (in the case of the GOA TMAA, complex bathymetric and oceanographic conditions include a continental shelf, submarine canyons, seamounts, and fresh water infusions from multiple sources), the Navy does not typically conduct successive ASW exercises in the same locations. Given the average length of ASW exercises (times of continuous sonar use) and typical vessel speed, combined with the fact that the majority of the cetaceans in the GOA TMAA Study Area would not likely remain in an area for successive days, it is unlikely that an animal would be exposed to MFAS/HFAS at levels likely to result in a substantive response that would then be carried on for more than one day or on successive days.

With the exception of SINKEXs, the planned explosive exercises for the GOA TMAA are of a short duration (1–6 hours). Although explosive exercises may sometimes be conducted in the same general areas repeatedly, because of their short duration and the fact that they are in the open ocean and animals can easily move away, it is similarly unlikely that animals would be exposed for long, continuous amounts of time. Although SINKEXs may last for up to 48 hrs, only two are planned annually for the GOA TMAA training activities, 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 procedures, all of which make it unlikely that individuals would be exposed to the exercise for extended periods or on consecutive days.

TTS

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. 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 powerful MF sources used 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. Vocalization data for each species, which would inform how TTS might specifically interfere with communications with conspecifics, was provided in the LOA application.

2. Degree of the shift (*i.e.,* by how many dB the sensitivity of the hearing is reduced)—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 was discussed previously in this proposed rule. 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 Lookouts and the nominal speed of an active sonar vessel (10–15 knots). In the TTS studies (see *Threshold Shift* section), 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-second exposure to a 20 kHz source. However, MFAS emits a ping typically every 50 seconds, and incurring those levels of TTS is highly unlikely.

3. Duration of TTS (recovery time)—In the TTS laboratory studies (see *Threshold Shift* section), 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), although 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 any incident of TTS would likely be far less severe due to the short duration of the majority of the exercises and the speed of a typical vessel). 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 received level) would not usually span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues. If impaired, marine mammals would typically be aware of their impairment and are sometimes able to implement behaviors to compensate (see Acoustic Masking or Communication Impairment section), though these compensations may incur energetic costs.

Acoustic Masking or Communication Impairment

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 typically pings every 50 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 50 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, communication series, or other critical auditory cue, 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. The other sources used in Navy training and testing, many of either higher frequencies (meaning that the sounds generated attenuate even closer to the source) or lower amounts of operation, are similarly not expected to result in masking.

PTS, Injury, or Mortality

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 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.

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 10–15 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. Only 5 Level A (PTS) takes per year are predicted from GOA training activities, and these are all Dall's porpoise—not large whale species or beaked whales. We also assume that the acoustic exposures sufficient to trigger onset PTS (or TTS) would be accompanied by physiological stress responses, although the sound characteristics that correlate with specific stress responses in marine mammals are poorly understood. As discussed above for Behavioral Harassment, we would not expect the Navy's generally short-term, intermittent, and (in the case of sonar) transitory activities to create conditions of long-term, continuous noise leading to long-term physiological stress responses in marine mammals. No other injurious takes or mortality are predicted. 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 mechanism of this potential response, behavioral or physiological, is 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. When this is combined with consideration of the number of hours of active sonar training that will be conducted and the total duration of all training exercises (a maximum of 21 days once or twice a year), we believe 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.

As stated previously, there have been no recorded Navy vessel strikes of any marine mammals during training in the GOA Study Area to date, nor were takes by injury or mortality resulting from vessel strike predicted in the Navy's analysis.

Group and Species-Specific Analysis

Predicted effects on marine mammals from exposures to sonar and other active acoustic sources and explosions during annual training activities are shown in Table 13. The vast majority of predicted exposures (greater than 99 percent) are expected to be Level B harassment (non-injurious TTS and behavioral reactions) from sonar and other active acoustic sources at relatively low received levels (Table 14). The acoustic analysis predicts the majority of marine mammal species in the Study Area would not be exposed to explosive (impulsive) sources associated with training activities. Only Dall's porpoise is predicted to have Level B (TTS) exposures resulting from explosives, and only a limited number (5) of Dall's porpoise are expected to have injurious take (PTS) resulting from sonar and other active acoustic sources and explosions. There are no lethal takes predicted for any marine mammal species for the GOA activities.

The analysis below may in some cases (*e.g.,* mysticetes, porpoises, pinnipeds) address species collectively if they occupy the same functional hearing group (*i.e.,* low-, mid-, and high-frequency cetaceans and pinnipeds in water), have similar hearing capabilities, and/or are known to generally behaviorally respond similarly to acoustic stressors. Where there are meaningful differences between species or stocks in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, they will either be described within the section or the species will be included as a separate sub-section.

Mysticetes—The Navy's acoustic analysis predicts that 2,923 instances of Level B harassmant of mysticete whales may occur in the Study Area each year from sonar and other active acoustic sources during training activities. Annual species-specific take estimates are as follows: 7 North Pacific right whales (Eastern North Pacific stock), 139 humpback whales (Central North Pacific and Western North Pacific stocks), 95 blue whales (Eastern North Pacific stock), 2,582 fin whales (Northeast Pacific stock), 13 sei whales (Eastern North Pacific stock), and 87 minke whales (Alaska stock). Of these species, humpback, blue, fin, sei, and North Pacific right whales are listed as endangered under the ESA and depleted under the MMPA. NMFS is currently engaged in an internal Section 7 consultation under the ESA and the outcome of that consultation will further inform our final decision. Based on the distribution information presented in the LOA application, it is highly unlikely that gray whales would be encountered in the Study Area during events involving use of sonar and other active acoustic sources. The acoustic analysis did not predict any takes of gray whales and NMFS is not authorizing any takes of this species.

Generally, these represent a limited number of takes relative to population estimates for most mysticete stocks in the Study Area (Table 6). When the numbers of behavioral takes are compared to the estimated stock abundance and if one assumes that each take happens to a separate animal, less than approximately 20 percent of each of these stocks (with the exception of the Northeast Pacific stock of fin whale and the Alaska stock of minke whale for which there currently are no reliable population estimates because only portions of the stocks' range have been surveyed [Muto and Angliss, 2015]) would be behaviorally harassed during the course of a year. Because the estimates given above represent the total number of exposures and not necessarily the number of individuals exposed, it is more likely that fewer individuals would be taken, but a subset would be taken more than one time per year. In the ocean, the use of sonar and other active acoustic sources is transient and is unlikely to repeatedly expose the same population of animals over a short period.

Level B harassment takes are anticipated to be in the form of TTS and behavioral reactions and no injurious takes of North Pacific right, humpback, blue, fin, minke, or sei whales from sonar and other active acoustic stressors or explosives are expected. The majority of acoustic effects to mysticetes from sonar and other active sound sources during training activities would be primarily from anti-submarine warfare events involving surface ships and hull mounted sonar. Research and observations show that if mysticetes are exposed to sonar or other active acoustic sources they may react in a number of ways depending on the characteristics of the sound source, their experience with the sound source, and whether they are migrating or on seasonal grounds (*i.e.,* breeding or feeding). Reactions may include alerting, breaking off feeding dives and surfacing, diving or swimming away, or no response at all (Richardson, 1995; Nowacek, 2007; Southall *et al.,* 2007; Finneran and Jenkins, 2012). Richardson *et al.* (1995) noted that avoidance (temporary displacement of an individual from an area) reactions are the most obvious manifestations of disturbance in marine mammals. Avoidance is qualitatively different from the startle or 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. Additionally, migrating animals may ignore a sound source, or divert around the source if it is in their path.

Specific to U.S. Navy systems using low frequency sound, studies were undertaken in 1997–98 pursuant to the Navy's Low Frequency Sound Scientific Research Program. These studies found only short-term responses to low frequency sound by mysticetes (fin, blue, and humpback whales) including changes in vocal activity and avoidance of the source vessel (Clark, 2001; Miller *et al.,* 2000; Croll *et al.,* 2001; Fristrup *et al.,* 2003; Nowacek *et al.,* 2007). Baleen whales exposed to moderate low-frequency signals demonstrated no variation in foraging activity (Croll *et al.,* 2001). Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000).

Specific to mid-frequency sound, studies by Melcón *et al.* (2012) in the Southern California Bight found that the likelihood of blue whale low-frequency calling (usually associated with feeding behavior) decreased with an increased level of MFAS, beginning at a SPL of approximately 110–120 dB re 1 μPa. However, it is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. Results from the 2010–2011 field season of an ongoing behavioral response study in Southern California waters indicated that in some cases and at low received levels, tagged blue whales responded to MFAS but that those responses were mild and there was a quick return to their baseline activity (Southall *et al.,* 2011; Southall *et al.,* 2012b). Blue whales responded to a mid-frequency sound source, with a source level between 160 and 210 dB re 1 μPa at 1 m and a received sound level up to 160 dB re 1 μPa, by exhibiting generalized avoidance responses and changes to dive behavior during the exposure experiments (CEE) (Goldbogen *et al.,* 2013). However, reactions were not consistent across individuals based on received sound levels alone, and likely were the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (MFAS simulation vs. pseudo-random noise), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during CEEs, but deep feeding and non-feeding whales showed temporary reactions that quickly abated after sound exposure. Distances of the sound source from the whales during CEEs were sometimes less than a mile. Blue whales have been documented exhibiting a range of foraging strategies for maximizing feeding dependent on the density of their prey at a given location (Goldbogen *et al.,* 2015), so it may be that a temporary behavioral reaction or avoidance of a location where feeding was occurring is not meaningful to the life history of an animal. The preliminary findings from Goldbogen *et al.* (2013) and Melcón *et al.* (2012) are generally consistent with the Navy's criteria and thresholds for predicting behavioral effects to mysticetes from sonar and other active acoustic sources used in the quantitative acoustic effects analysis for GOA. The Navy's behavioral response function predicts the probability of a behavioral response that rises to a Level B take for individuals exposed to a received SPL of 120 dB re 1 µPa or greater, with an increasing probability of reaction with increased received level as demonstrated in Melcón *et al.* (2012).

High-frequency systems are notably outside of mysticetes' ideal hearing and vocalization range and it is unlikely that they would cause a significant behavioral reaction.

Most Level B harassments to mysticetes from sonar in the Study Area would result from received levels less than 156 dB SPL. Therefore, the majority of Level B takes are expected to be in the form of milder responses (*i.e.,* lower-level exposures that still rise to the level of take, but would likely be less severe in the range of responses that qualify as take) of a generally short duration. As mentioned earlier in this section, we anticipate more severe effects from takes when animals are exposed to higher received levels. Most low-frequency (mysticetes) cetaceans observed in studies usually avoided sound sources at levels of less than or equal to 160 dB re 1µPa. Occasional milder behavioral reactions are unlikely to cause long-term consequences for individual animals or populations. Even if sound exposure were to be concentrated in a relatively small geographic area over a long period of time (*e.g.,* days or weeks during major training exercises), we would expect that some individual whales would avoid areas where exposures to acoustic stressors are at higher levels. For example, Goldbogen *et al.* (2013) indicated some horizontal displacement of deep foraging blue whales in response to simulated MFA sonar. Given these animal's mobility and large ranges, we would expect these individuals to temporarily select alternative foraging sites nearby until the exposure levels in their initially selected foraging area have decreased. Therefore, even temporary displacement from initially selected foraging habitat is not expected to impact the fitness of any individual animals because we would expect equivalent foraging to be available in close proximity. Because we do not expect any fitness consequences from any individual animals, we do not expect any population level effects from these behavioral responses.

As explained above, recovery from a threshold shift (TTS) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Finneran and Schlundt, 2010; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b). However, large threshold shifts are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's hearing of biologically relevant sounds. Furthermore, the implementation of mitigation and the sightability of mysticetes (due to their large size) reduces the potential for a significant behavioral reaction or a threshold shift to occur.

Overall, the number of predicted behavioral reactions is low and occasional behavioral reactions are unlikely to cause long-term consequences for individual animals or populations. This assessment of long-term consequences is based in part on findings from ocean areas where the Navy has been intensively training and testing with sonar and other active acoustic sources for decades. While there are many factors such as the end of large-scale commercial whaling complicating any analysis, there is no data suggesting any long-term consequences to mysticetes from exposure to sonar and other active acoustic sources. On the contrary, there are findings suggesting mysticete populations are increasing in the two primary locations (Southern California and Hawaii) where the Navy's most intensively used range complexes are located. These findings include: (1) Calambokidis *et al.* (2009b) indicating a significant upward trend in abundance of for blue whales in Southern California; (2) the recovery of gray whales that migrate through the Navy's SOCAL Range Complex twice a year; (3) work by Moore and Barlow (2011) indicating evidence of increasing fin whale abundance in the California Current area, which includes the SOCAL Range Complex; (4) the range expansion and increasing presence of Bryde's whales south of Point Conception in Southern California (Kerosky *et al.* 2012); and (5) the ocean area contained within the Hawaii Range Complex continuing to function as a critical breeding, calving, and nursing area to the point at which the overall humpback whale population in the North Pacific is now greater than some prior estimates of pre-whaling abundance (Barlow *et al.,* 2011). The implementation of mitigation and the sightability of mysticetes (due to their large size) reduces the potential for a significant behavioral reaction or a threshold shift to occur. Furthermore, there is no designated critical habitat for mysticetes in the Study Area. As discussed in the *Consideration of Time/Area Limitations* section of this rule, review of the NMFS-identified feeding and migration areas showed there is only minimal (<1 percent) spatial overlap with the GOA TMAA and the North Pacific right whale feeding area southeast of Kodiak Island and minimal (<1 percent) spatial overlap with a small portion of the gray whale migration area offshore of Kenai Peninsula (Ferguson *et al.,* 2015b). Those areas of overlap at the corners of the GOA TMAA are very unlikely to have any Navy training activity. Further, the grey whale migration area is only applicable in the early spring and late fall, while training activities are proposed for May to October (with June/July the main months of training, historically). Therefore, it is very unlikely there would be an effect to feeding or migrating activities if right whales or gray whales were present. Additionally, appropriate mitigation measures (as detailed in the Mitigation section above) would be implemented for any detected marine mammals and thus further reducing the potential for the feeding or migration activities to be affected. The Navy proposes to monitor use of active sonar within the North Pacific right whale feeding area and gray whale migration areas, to the extent that active sonar training does occur in these areas, and to report that use to NMFS in classified annual reports (see Proposed Reporting) to inform future adaptive management of activities within the GOA TMAA.

Consequently, the GOA TMAA activities are not expected to adversely impact rates of recruitment or survival of mysticete whales.

Sperm Whales—The Navy's acoustic analysis indicates that 197 instances of Level B harassment of sperm whales (North Pacific stock; currently there are no reliable abundance estimates for this stock [Muto and Angliss, 2015]) may occur in the Study Area each year from sonar or other active acoustic stressors during training activities. Sperm whales are listed as endangered under the ESA and depleted under the MMPA. NMFS is currently engaged in an internal Section 7 consultation under the ESA and the outcome of that consultation will further inform our final decision. These Level B takes are anticipated to be in the form of TTS and behavioral reactions and no injurious takes of sperm whales from sonar and other active acoustic stressors or explosives are requested or proposed for authorization. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior (Richardson, 1995; Nowacek, 2007; Southall *et al.,* 2007; Finneran and Jenkins, 2012). Some (but not all) sperm whale vocalizations might overlap with the MFAS/HFAS TTS frequency range, which could 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. Recovery from a threshold shift (TTS) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b; Finneran and Schlundt, 2010). Large threshold shifts are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's hearing of biologically relevant sounds. No sperm whales are predicted to be exposed to MFAS/HFAS sound levels associated with PTS or injury.

The majority of Level B takes are expected to be in the form of mild responses (low-level exposures) and of a generally short duration. Relative to the population size, this activity is anticipated to result only in a limited number of Level B harassment takes. Because the estimates given above represent the total number of exposures and not necessarily the number of individuals exposed, it is more likely that fewer individuals would be taken, but a subset would be taken more than one time per year. In the ocean, the use of sonar and other active acoustic sources is transient and is unlikely to repeatedly expose the same population of animals over a short period. Overall, the number of predicted behavioral reactions are unlikely to cause long-term consequences for individual animals or populations. The GOA activities are not expected to occur in an area/time of specific importance for reproductive, feeding, or other known critical behaviors for sperm whales, and there is no designated critical habitat in the Study Area. Consequently, the activities are not expected to adversely impact annual rates of recruitment or survival of sperm whales.

Dolphins and Small Whales—The Navy's acoustic analysis predicts the following instances of Level B harassment of delphinids (dolphins and small whales) each year from sonar and other active acoustic sources associated with training activities in the Study Area: 762 killer whales (Alaska Resident; Eastern North Pacific Offshore; AT1 Transient; and GOA, Aleutian Island, and Bearing Sea Transient stocks) and 1,963 Pacific white-sided dolphins (North Pacific stock). These represent a limited number of takes relative to population estimates for delphinid stocks in the Study Area (Table 6). When the numbers of behavioral takes are compared to the estimated stock abundance and if one assumes that each take happens to a separate animal, less than 25 percent of each of the killer whale stocks and less than 8 percent of the North Pacific stock of Pacific white-sided dolphin would be behaviorally harassed during the course of a year. More likely, slightly fewer individuals would be harassed, but a subset would be harassed more than one time during the course of the year.

All of these takes are anticipated to be in the form of behavioral harassment (TTS and behavioral reaction) and no injurious takes of delphinids from sonar and other active acoustic stressors or explosives are requested or proposed for authorization. Further, the majority of takes are anticipated to be by behavioral harassment in the form of mild responses. Research and observations show that if delphinids are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Delphinids may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the environmental conditions and species. Delphinids that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the sound source by swimming away or diving, or be attracted to the sound source (Richardson, 1995; Nowacek, 2007; Southall *et al.,* 2007; Finneran and Jenkins, 2012). Research has demonstrated that Alaska Resident killer whales may routinely move over long large distances (Andrews and Matkin, 2014; Fearnbach *et al.,* 2013). In a similar documented long-distance movement, an Eastern North Pacific Offshore stock killer whale tagged off San Clemente Island, California, moved (over a period of 147 days) to waters off northern Mexico, then north to Cook Inlet, Alaska, and finally (when the tag ceased transmitting) to coastal waters off Southeast Alaska (Falcone and Schorr, 2014). Given these findings, temporary displacement due to avoidance of training activities are therefore unlikely to have biological significance to individual animals.

Delphinid species generally travel in large pods and should be visible from a distance in order to implement mitigation measures and reduce potential impacts. Many of the recorded delphinid vocalizations overlap with the MFAS/HFAS TTS frequency range (2–20 kHz); however, as noted above, NMFS does not anticipate TTS of a serious degree or extended duration to occur as a result of exposure to MFAS/HFAS. Recovery from a threshold shift (TTS) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Finneran and Schlundt, 2010; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b). However, large threshold shifts are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's hearing of biologically relevant sounds. Their size and detectability makes it unlikely that these animals would be exposed to the higher energy or pressure expected to result in more severe effects.

The predicted effects to delphinids are unlikely to cause long-term consequences for individual animals or populations. The GOA TMAA activities are not expected to occur in an area/time of specific importance for reproductive, feeding, or other known critical behaviors for delphinids. Stocks of delphinid species found in the Study Area are not depleted under the MMPA, nor are they listed under the ESA. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of delphinid species.

Porpoises—The Navy's acoustic analysis predicts that 16,244 instances of Level B harassment (TTS and behavioral) of Dall's porpoise (Alaska stock) and 7,410 instances of Level B harassment of harbor porpoise (GOA and Southeast Alaska stocks) may occur each year from sonar and other active acoustic sources and explosives associated with training and testing activities in the Study Area. These represent a limited number of takes relative to population estimates for porpoise stocks in the Study Area (Table 6). When the numbers of takes for Dall's and harbor porpoise are compared to their respective estimated stock abundances and if one assumes that each take happens to a separate animal, less than 20 percent of the Alaska stock of Dall's porpoise, and less than 18 percent of the GOA and Southeast Alaska stocks of harbor porpoise would be harassed (behaviorally) during the course of a year. Because the estimates given above represent the total number of exposures and not necessarily the number of individuals exposed, it is more likely that fewer individuals would be taken, but a subset would be taken more than one time per year.

Behavioral responses can range from a mild orienting response, or a shifting of attention, to flight and panic (Richardson, 1995; Nowacek, 2007; Southall *et al.,* 2007). Acoustic analysis (factoring in the post-model correction for avoidance and mitigation) also predicted that 5 Dall's porpoises might be exposed to sound levels from sonar and other active acoustic stressors and explosives likely to result in PTS or injury (Level A harassment).

The number of Dall's and harbor porpoise behaviorally harassed by exposure to MFAS/HFAS in the Study Area is generally higher than the other species. This is due to the low Level B harassment threshold (we assume for the purpose of estimating take that all harbor porpoises exposed to 120 dB or higher MFAS/HFAS will be taken by Level B behavioral harassment), which essentially makes the ensonified area of effects significantly larger than for the other species. However, the fact that the threshold is a step function and not a curve (and assuming uniform density) means that the vast majority of the takes occur in the very lowest levels that exceed the threshold (it is estimated that approximately 80 percent of the takes are from exposures to 120 dB–126 dB), which means that anticipated behavioral effects are not expected to be severe (*e.g.,* temporary avoidance). 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 an animal. Animals that do not exhibit a significant behavioral reaction would likely recover from any incurred costs, which reduces the likelihood of long-term consequences, such as reduced fitness, for the individual or population.

Animals that experience hearing loss (TTS or PTS) may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. Some porpoise vocalizations might overlap with the MFAS/HFAS TTS frequency range (2–20 kHz). Recovery from a threshold shift (TTS; partial hearing loss) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b; Finneran and Schlundt, 2010). More severe shifts may not fully recover and thus would be considered PTS. However, large degrees of PTS are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. The likely consequences to the health of an individual that incurs PTS can range from mild to more serious, depending 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. Furthermore, likely avoidance of intense activity and sound coupled with mitigation measures would further reduce the potential for severe PTS exposures to occur. 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 10–15 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.

Harbor porpoises have been observed to be especially sensitive to human activity (Tyack *et al.,* 2011; Pirotta *et al.,* 2012). The information currently available regarding harbor porpoises suggests a very low threshold level of response for both captive (Kastelein *et al.,* 2000; Kastelein *et al.,* 2005) and wild (Johnston, 2002) animals. Southall *et al.* (2007) concluded that harbor porpoises are likely sensitive to a wide range of anthropogenic sounds at low received levels (~ 90 to 120 dB). Research and observations of harbor porpoises for other locations show that this small species is wary of human activity and will display profound avoidance behavior for anthropogenic sound sources in many situations at levels down to 120 dB re 1 μPa (Southall, 2007). Harbor porpoises routinely avoid and swim away from large motorized vessels (Barlow *et al.,* 1988; Evans *et al.,* 1994; Palka and Hammond, 2001; Polacheck and Thorpe, 1990). The vaquita, which is closely related to the harbor porpoise in the Study Area, appears to avoid large vessels at about 2,995 ft. (913 m) (Jaramillo-Legorreta *et al.,* 1999). The assumption is that the harbor porpoise would respond similarly to large Navy vessels, possibly prior to commencement of sonar or explosive activity (*i.e.,* pre-activity avoidance). Harbor porpoises may startle and temporarily leave the immediate area of the training or testing until after the event ends.

ASW training exercises using MFAS/HFAS generally last for 2–16 hours, and may have intervals of non-activity in between. In addition, the Navy does not typically conduct ASW exercises in the same locations. Given the average length of ASW exercises (times of continuous sonar use) and typical vessel speed, combined with the fact that the majority of porpoises in the Study Area would not likely remain in an area for successive days, it is unlikely that an animal would be exposed to MFAS/HFAS at levels likely to result in a substantive response (*e.g.,* interruption of feeding) that would then be carried on for more than one day or on successive days. Thompson *et al.* (2013) showed that seismic surveys conducted over a 10-day period in the North Sea did not result in the broad-scale displacement of harbor porpoises away from preferred habitat. The harbor porpoises were observed to leave the area at the onset of survey, but returned within a few hours, and the overall response of the porpoises decreased over the 10-day period.

Considering the information above, the predicted effects to Dall's and harbor porpoise are unlikely to cause long-term consequences for individual animals or the population. The GOA activities are not expected to occur in an area/time of specific importance for reproductive, feeding, or other known critical behaviors for Dall's and harbor porpoise. Stocks of Dall's and harbor porpoise are not listed as depleted under the MMPA. Consequently, the activities are not expected to adversely impact annual rates of recruitment or survival of porpoises.

Beaked Whales—Acoustic analysis predicts that 401 Baird's beaked whales (Alaska stock), 2,544 Cuvier's beaked whales (Alaska stock), and 1,153 Stejneger's beaked whales (Alaska stock) will be taken annually by Level B harassment from exposure to sonar and other active acoustic stressors. These takes are anticipated to be in the form of behavioral harassment (mainly behavioral reaction and some TTS) and no injurious takes of beaked whales from sonar and other active acoustic stressors or explosives are requested or proposed. Relative to population size, training activities are anticipated to result only in a limited number of takes. Because the estimates given above represent the total number of exposures and not necessarily the number of individuals exposed, it is more likely that fewer individuals would be taken, but a subset would be taken more than one time per year. There are currently no reliable abundance estimates for Alaska stocks of Baird's, Cuvier's, and Stejner's beaked whales (Muto and Angliss, 2015).

As is the case with harbor porpoises, beaked whales have been shown to be particularly sensitive to sound and therefore have been assigned a lower harassment threshold based on observations of wild animals by McCarthy *et al.* (2011) and Tyack *et al.* (2011). The fact that the Level B harassment threshold is a step function (The Navy has adopted an unweighted 140 dB re 1 μPa SPL threshold for significant behavioral effects for all beaked whales) and not a curve (and assuming uniform density) means that the vast majority of the takes occur in the very lowest levels that exceed the threshold (it is estimated that approximately 80 percent of the takes are from exposures to 140 dB to 146 dB), which means that the anticipated effects for the majority of exposures are not expected to be severe (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 an animal). Further, Moretti *et al.* (2014) recently derived an empirical risk function for Blainville's beaked whale that predicts there is a 0.5 probability of disturbance at a received level of 150 dB (CI: 144–155), suggesting that in some cases the current Navy step function may over-estimate the effects of an activity using sonar on beaked whales. Irrespective of the Moretti *et al.* (2014) risk function, NMFS' analysis assumes that all of the beaked whale Level B takes that are proposed for authorization will occur, and we base our negligible impact determination, in part, on the fact that these exposures would mainly occur at the very lowest end of the 140-dB behavioral harassment threshold where behavioral effects are expected to be much less severe and generally temporary in nature.

Behavioral responses can range from a mild orienting response, or a shifting of attention, to flight and panic (Richardson, 1995; Nowacek, 2007; Southall *et al.,* 2007; Finneran and Jenkins, 2012). Research has also shown that beaked whales are especially sensitive to the presence of human activity (Tyack *et al.,* 2011; Pirotta *et al.,* 2012). Beaked whales have been documented to exhibit avoidance of human activity or respond to vessel presence (Pirotta *et al.,* 2012). Beaked whales were observed to react negatively to survey vessels or low altitude aircraft by quick diving and other avoidance maneuvers, and none were observed to approach vessels (Wursig *et al.,* 1998). Some beaked whale vocalizations may overlap with the MFAS/HFAS TTS frequency range (2–20 kHz); however, as noted above, NMFS does not anticipate TTS of a serious degree or extended duration to occur as a result of exposure to MFA/HFAS. Recovery from a threshold shift (TTS) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b; Finneran and Schlundt, 2010). Large threshold shifts are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal's hearing of biologically relevant sounds.

It has been speculated for some time that beaked whales might have unusual sensitivities to sonar sound due to their likelihood of stranding in conjunction with MFAS use. Research and observations show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives, and avoid the area of the sound source to levels of 157 dB re 1 μPa, or below (McCarthy *et al.,* 2011). Acoustic monitoring during actual sonar exercises revealed some beaked whales continuing to forage at levels up to 157 dB re 1 μPa (Tyack *et al.* 2011). Stimpert *et al.* (2014) tagged a Baird's beaked whale, which was subsequently exposed to simulated MFAS. Changes in the animal's dive behavior and locomotion were observed when received level reached 127 dB re 1μPa. However, Manzano-Roth *et al.* (2013) found that for beaked whale dives that continued to occur during MFAS activity, differences from normal dive profiles and click rates were not detected with estimated received levels up to 137 dB re 1 μPa while the animals were at depth during their dives. And in research done at the Navy's fixed tracking range in the Bahamas, animals were observed to leave the immediate area of the anti-submarine warfare training exercise (avoiding the sonar acoustic footprint at a distance where the received level was ''around 140 dB'' SPL, according to Tyack *et al.* [2011]) but return within a few days after the event ended (Claridge and Durban, 2009; Moretti *et al.,* 2009, 2010; Tyack *et al.,* 2010, 2011; McCarthy *et al.,* 2011). Tyack *et al.* (2011) report that, in reaction to sonar playbacks, most beaked whales stopped echolocating, made long slow ascent to the surface, and moved away from the sound. A similar behavioral response study conducted in Southern California waters during the 2010–2011 field season found that Cuvier's beaked whales exposed to MFAS displayed behavior ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source (DeRuiter *et al.,* 2013b). However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (*e.g.,* source proximity, controlled source ramp-up) may have been a significant factor. The study itself found the results inconclusive and meriting further investigation. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale.

Populations of beaked whales and other odontocetes on the Bahamas and other Navy fixed ranges that have been operating for decades, appear to be stable. Behavioral reactions (avoidance of the area of Navy activity) seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers, especially for prolonged periods (a few hours or more) since this is one of the most sensitive marine mammal groups to anthropogenic sound of any species or group studied to date and research indicates beaked whales will leave an area where anthropogenic sound is present (Tyack *et al.,* 2011; De Ruiter *et al.,* 2013; Manzano-Roth *et al.,* 2013; Moretti *et al.,* 2014). Research involving tagged Cuvier's beaked whales in the SOCAL Range Complex reported on by Falcone and Schorr (2012, 2014) indicates year-round prolonged use of the Navy's training and testing area by these beaked whales and has documented movements in excess of hundreds of kilometers by some of those animals. Given that some of these animals may routinely move hundreds of kilometers as part of their normal pattern, leaving an area where sonar or other anthropogenic sound is present may have little, if any, cost to such an animal. Photo identification studies in the SOCAL Range Complex, a Navy range that is utilized for training and testing more frequently than the GOA TMAA Study Area, have identified approximately 100 individual Cuvier's beaked whale individuals with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone and Schorr, 2014). These results indicate long-term residency by individuals in an intensively used Navy training and testing area, which may also suggest a lack of long-term consequences as a result of exposure to Navy training and testing activities. Finally, results from passive acoustic monitoring estimated regional Cuvier's beaked whale densities were higher than indicated by the NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald, 2009).

Based on the findings above, it is clear that the Navy's long-term ongoing use of sonar and other active acoustic sources has not precluded beaked whales from also continuing to inhabit those areas. In summary, based on the best available science, the Navy and NMFS believe that beaked whales that exhibit a significant TTS or behavioral reaction due to sonar and other active acoustic testing activities would generally not have long-term consequences for individuals or populations. Claridge (2013) speculated that sonar use in a Bahamas range could have ''a possible population-level effect'' on beaked whales based on lower abundance in comparison to control sites. In summary, Claridge suggested that lower reproductive rates observed at the Navy's Atlantic Undersea Test and Evaluation Center (AUTEC), when compared to a control site, were due to stressors associated with frequent and repeated use of Navy sonar. It is also important to note that there were some relevant shortcomings of this study. For example, all of the re-sighted whales during the 5-year study at both sites were female, which Claridge acknowledged can lead to a negative bias in the abundance estimation. There was also a reduced effort and shorter overall study period at the AUTEC site that failed to capture some of the emigration/immigration trends identified at the control site. Furthermore, Claridge assumed that the two sites were identical and therefore should have equal potential abundances; when in reality, there were notable physical differences. The author also acknowledged that ''information currently available cannot provide a quantitative answer to whether frequent sonar use at [the Bahamas range] is causing stress to resident beaked whales,'' and cautioned that the outcome of ongoing studies ''is a critical component to understanding if there are population-level effects.'' Moore and Barlow (2013) have noted a decline in beaked whale populations in a broad area of the Pacific Ocean area out to 300 nm from the coast and extending from the Canadian-U.S. border to the tip of Baja Mexico. There are scientific caveats and limitations to the data used for that analysis, as well as oceanographic and species assemblage changes on the U.S. Pacific coast not thoroughly addressed. Although Moore and Barlow (2013) have noted a decline in the overall beaked whale population along the Pacific coast, in the small fraction of that area where the Navy has been training and testing with sonar and other systems for decades (the Navy's SOCAL Range Complex), higher densities and long-term residency by individual Cuvier's beaked whales suggest that the decline noted elsewhere is not apparent where Navy sonar use is most intense. Navy sonar training and testing is not conducted along a large part of the U.S. west coast from which Moore and Barlow (2013) drew their survey data. In Southern California, based on a series of surveys from 2006 to 2008 and a high number encounter rate, Falcone *et al.* (2009) suggested the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales given the number of animals encountered there. Follow-up research (Falcone and Schorr, 2012, 2014) in this same location suggests that Cuvier's beaked whales may have population sub-units with higher than expected residency, particularly in the Navy's instrumented Southern California Anti-Submarine Warfare Range. Encounters with multiple groups of Cuvier's and Baird's beaked whales indicated not only that they were prevalent on the range where Navy routinely trains and tests, but also that they were potentially present in much higher densities than had been reported for anywhere along the U.S. west coast (Falcone *et al.,* 2009, Falcone and Schorr, 2012). This finding is also consistent with concurrent results from passive acoustic monitoring that estimated regional Cuvier's beaked whale densities were higher where Navy trains in the SOCAL training and testing area than indicated by NMFS's broad scale visual surveys for the U.S. west coast (Hildebrand and McDonald, 2009).

NMFS also considered New *et al.* (2013) and their mathematical model simulating a functional link between foraging energetics and requirements for survival and reproduction for 21 species of beaked whales. However, NMFS concluded that New *et al.* (2013) model lacks critical data and accurate inputs necessary to form valid conclusions specifically about impacts of anthropogenic sound from Navy activities on beaked whale populations. The study itself notes the need for ''future research,'' identifies ''key data needs'' relating to input parameters that ''particularly affected'' the model results, and states only that the use of the model ''in combination with more detailed research'' *could* help predict the effects of management actions on beaked whale species. In short, information is not currently available to specifically support the use of this model in a project-specific evaluation of the effects of Navy activities on the impacted beaked whale species in GOA.

No beaked whales are predicted in the acoustic analysis to be exposed to sound levels associated with PTS, other injury, or mortality. After decades of the Navy conducting similar activities in the GOA Study Area without incident, NMFS does not expect strandings, injury, or mortality of beaked whales to occur as a result of training activities. Stranding events coincident with Navy MFAS use in which exposure to sonar is believed to have been a contributing factor were detailed in the Stranding and Mortality section of this proposed rule. However, for some of these stranding events, a causal relationship between sonar exposure and the stranding could not be clearly established (Cox *et al.,* 2006). In other instances, sonar was considered only one of several factors that, in their aggregate, may have contributed to the stranding event (Freitas, 2004; Cox *et al.,* 2006). Because of the association between tactical MFAS use and a small number of marine mammal strandings, the Navy and NMFS have been considering and addressing the potential for strandings in association with Navy activities for years. In addition to a suite of mitigation measures intended to more broadly minimize impacts to marine mammals, the reporting requirements set forth in this rule ensure that NMFS is notified immediately (or as soon as clearance procedures allow) if a stranded marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations (see General Notification of Injured or Dead Marine Mammals and the Stranding Response Plan in the regulatory text below). Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding.

The GOA training activities are not expected to occur in an area/time of specific importance for reproductive, feeding, or other known critical behaviors for beaked whales. None of the Pacific stocks for beaked whales species found in the Study Area are depleted under the MMPA. The degree of predicted Level B harassment is expected to be mild, and no beaked whales are predicted in the acoustic analysis to be exposed to sound levels associated with PTS, other injury, or mortality. Consequently, the activities are not expected to adversely impact annual rates of recruitment or survival of beaked whales.

Pinnipeds—The Navy's acoustic analysis predicts that the following numbers of Level B harassment (TTS and behavioral reaction) may occur annually from sonar and other active acoustic stressors associated with training activities: 1,243 Steller sea lions (Eastern U.S. and Western U.S. stocks); 5 California sea lions (U.S. stock); 1,428 northern fur seals (Eastern Pacific stock); 245 northern elephant seals (California Breeding stock); and 4 harbor seals (North Kodiak, South Kodiak, and Prince William Sound stocks). These represent a limited number of takes relative to population estimates for pinniped stocks in the Study Area (Table 6). When the numbers of behavioral takes are compared to the estimated stock abundances, less than 2 percent of each of these stocks would be behaviorally harassed during the course of a year. These estimates 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. Based on the distribution information presented in the LOA application, it is highly unlikely that ribbon seals would be encountered in the Study Area during events involving use of sonar and other active acoustic sources or explosives. The acoustic analysis did not predict any takes of ribbon seals and NMFS is not authorizing any takes of this species.

Research has demonstrated that for pinnipeds, as for other mammals, recovery from a threshold shift (TTS) can take a few minutes to a few days, depending on the exposure duration, sound exposure level, and the magnitude of the initial shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran *et al.,* 2005; Finneran and Schlundt, 2010; Mooney *et al.,* 2009a; Mooney *et al.,* 2009b). However, large threshold shifts are not anticipated for these activities because of the unlikelihood that animals will remain within the ensonified area (due to the short duration of the majority of exercises, the speed of the vessels, and the short distance within which the animal would need to approach the sound source) at high levels for the duration necessary to induce larger threshold shifts. Threshold shifts do not necessarily affect all hearing frequencies equally, so threshold shifts may not necessarily interfere with an animal's ability to hear biologically relevant sounds.

Research and observations show that pinnipeds in the water may be tolerant of anthropogenic noise and activity (a review of behavioral reactions by pinnipeds to impulsive and non-impulsive noise can be found in Richardson *et al.,* 1995 and Southall *et al.,* 2007). Available data, though limited, suggest that exposures between approximately 90 and 140 dB SPL do not appear to induce strong behavioral responses in pinnipeds exposed to nonpulse sounds in water (Jacobs and Terhune, 2002; Costa *et al.,* 2003; Kastelein *et al.,* 2006c). Based on the limited data on pinnipeds in the water exposed to multiple pulses (small explosives, impact pile driving, and seismic sources), exposures in the approximately 150 to 180 dB SPL range generally have limited potential to induce avoidance behavior in pinnipeds (Harris *et al.,* 2001; Blackwell *et al.,* 2004; Miller *et al.,* 2004). If pinnipeds are exposed to sonar or other active acoustic sources they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Pinnipeds may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Houser *et al.* (2013) performed a controlled exposure study involving California sea lions exposed to a simulated MFAS signal. The purpose of this Navy-sponsored study was to determine the probability and magnitude of behavioral responses by California sea lions exposed to differing intensities of simulated MFAS signals. Behavioral reactions included increased respiration rates, prolonged submergence, and refusal to participate, among others. Younger animals were more likely to respond than older animals, while some sea lions did not respond consistently at any level. Houser *et al.*'s findings are consistent with current scientific studies and criteria development concerning marine mammal reactions to MFAS. Effects on pinnipeds in the Study Area that are taken by Level B harassment, on the basis of reports in the literature as well as Navy monitoring from past activities, will likely be limited to reactions such as increased swimming speeds, increased surfacing time, or decreased foraging (if such activity were occurring). Most likely, individuals will simply move away from the sound source and be temporarily displaced from those areas, or not respond at all. In areas of repeated and frequent acoustic disturbance, some animals may habituate or learn to tolerate the new baseline or fluctuations in noise level. Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). While some animals may not return to an area, or may begin using an area differently due to training and testing activities, most animals are expected to return to their usual locations and behavior. Given their documented tolerance of anthropogenic sound (Richardson *et al.,* 1995 and Southall *et al.,* 2007), repeated exposures of individuals (*e.g.,* harbor seals) to levels of sound that may cause Level B harassment are unlikely to result in hearing impairment or to significantly disrupt foraging behavior. As stated above, pinnipeds may habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past has not accompanied any overt threat.

Thus, even repeated Level B harassment of some small subset of an overall stock is unlikely to result in any significant realized decrease in fitness to those individuals, and would not result in any adverse impact to the stock as a whole. Evidence from areas where the Navy extensively trains and tests provides some indication of the possible consequences resulting from those proposed activities. In the confined waters of Washington State's Hood Canal where the Navy has been training and intensively testing for decades and harbor seals are present year-round, the population level has remained stable suggesting the area's carrying capacity likely has been reached (Jeffries *et al.,* 2003; Gaydos *et al.,* 2013). Within Puget Sound there are several locations where pinnipeds use Navy structures (*e.g.,* submarines, security barriers) for haulouts. Given that animals continue to choose these areas for their resting behavior, it would appear there are no long-term effects or consequences to those animals as a result of ongoing and routine Navy activities.

Generally speaking, most pinniped stocks in the Study Area are thought to be stable or increasing (Carretta *et al.,* 2014, 2015). Abundance estimates for pinniped stocks in the Study Area are shown in Table 6. Relative to population size, training activities are anticipated to result only in a limited number of takes. No areas of specific importance for reproduction or feeding for pinnipeds have been identified in the Study Area. Consequently, the activities are not expected to adversely impact rates of recruitment or survival of pinniped species.

Western U.S. stocks of Steller sea lions are listed as endangered under the ESA; however, there is no designated critical habitat Steller sea lions in the Study Area. As a conservative measure, the GOA TMAA boundary zone was specifically drawn to exclude any nearby critical habitat and associated terrestrial, air, or aquatic zones. NMFS is currently engaged in an internal Section 7 consultation under the ESA and the outcome of that consultation will further inform our final determination.

Long-Term Consequences

The best assessment of long-term consequences from training activities will be to monitor the populations over time within a given Navy range complex. A U.S. workshop on Marine Mammals and Sound (Fitch *et al.,* 2011) indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival. The Navy has developed monitoring plans for protected marine mammals occurring on Navy ranges with the goal of assessing the impacts of training and testing activities on marine species and the effectiveness of the Navy's current mitigation practices. Continued monitoring efforts over time will be necessary to completely evaluate the long-term consequences of exposure to noise sources.

Since 2006 across all Navy range complexes (in the Atlantic, Gulf of Mexico, and the Pacific), there have been more than 80 reports, including Major Exercise Reports, Annual Exercise Reports, and Monitoring Reports. For the Pacific since 2011, there have been 29 monitoring and exercise reports submitted to NMFS to further research goals aimed at understanding the Navy's impact on the environment as it carries out its mission to train and test.

In addition to this multi-year record of reports from across the Navy, there have also been ongoing Behavioral Response Study research efforts (in Southern California and the Bahamas) specifically focused on determining the potential effects from Navy mid-frequency sonar (Southall *et al.,* 2011, 2012; McCarthy *et al.,* 2011; Tyack *et al.,* 2011; DeRuiter *et al.,* 2013b; Goldbogen *et al.,* 2013; Moretti *et al.,* 2014). This multi-year compendium of monitoring, observation, study, and broad scientific research is informative with regard to assessing the effects of Navy training and testing in general. Given that this record involves many of the same Navy training activities being considered for the Study Area and because it includes all the marine mammal taxonomic families and many of the same species, this compendium of Navy reporting is directly applicable to assessing locations such as the GOA TMAA.

In the Hawaii and Southern California Navy training and testing ranges from 2009 to 2012, Navy-funded marine mammal monitoring research completed over 5,000 hours of visual survey effort covering over 65,000 nautical miles, sighted over 256,000 individual marine mammals, took over 45,600 digital photos and 36 hours of digital video, attached 70 satellite tracking tags to individual marine mammals, and collected over 40,000 hours of passive acoustic recordings. In Hawaii alone between 2006 and 2012, there were 21 scientific marine mammal surveys conducted before, during, or after major exercises. This monitoring effort is consistent with other research from these areas in that there have been no direct evidence demonstration that routine Navy training and testing has negatively impacted marine mammal populations inhabiting these Navy ranges. Continued monitoring efforts over time will be necessary to completely evaluate the long-term consequences of exposure to noise sources. Other research findings related to the general topic of long-term impacts are discussed above in the Species-Specific Analysis.

Based on monitoring conducted before, during, and after Navy training and testing events since 2006, the NMFS' assessment is that it is unlikely there will be impacts having any long-term consequences to populations of marine mammals as a result of the proposed continuation of training and testing in the ocean areas historically used by the Navy including the Study Area. This assessment of likelihood is based on four indicators from areas in the Pacific where Navy training and testing has been ongoing for decades: (1) Evidence suggesting or documenting increases in the numbers of marine mammals present (Calambokidis and Barlow, 2004; Falcone *et al.,* 2009; Hildebrand and McDonald, 2009; Falcone and Shorr, 2012; Calambokidis *et al.,* 2009a; Berman-Kowalewski *et al.,* 2010; Moore and Barlow, 2011; Barlow *et al.,* 2011; Kerosky *et al,.* 2012; Smultea *et al.,* 2013; Širović *et al.,* 2015), (2) examples of documented presence and site fidelity of species and long-term residence by individual animals of some species (Hooker *et al.,* 2002; McSweeney *et al.,* 2007; McSweeney *et al.,* 2010; Martin and Kok, 2011; Baumann-Pickering *et al.,* 2012; Falcone and Schorr, 2014), (3) use of training and testing areas for breeding and nursing activities (Littnan, 2010), and (4) 6 years of comprehensive monitoring data indicating a lack of any observable effects to marine mammal populations as a result of Navy training and testing activities.

To summarize, while the evidence covers most marine mammal taxonomic suborders, it is limited to a few species and only suggestive of the general viability of those species in intensively used Navy training and testing areas (Barlow *et al.,* 2011; Calambokidis *et al.,* 2009b; Falcone *et al.,* 2009; Littnan, 2011; Martin and Kok, 2011; McCarthy *et al.,* 2011; McSweeney *et al.,* 2007; McSweeney *et al.,* 2009; Moore and Barlow, 2011; Tyack *et al.,* 2011; Southall *et al.,* 2012a; Melcon, 2012; Goldbogen, 2013; Baird *et al.,* 2013). However, there is no direct evidence that routine Navy training and testing spanning decades has negatively impacted marine mammal populations at any Navy Range Complex. Although there have been a few strandings associated with use of sonar in other locations (see U.S. Department of the Navy, 2013b), Ketten (2012) has recently summarized, ''to date, there has been no demonstrable evidence of acute, traumatic, disruptive, or profound auditory damage in any marine mammal as the result of anthropogenic noise exposures, including sonar.'' Therefore, based on the best available science (Barlow *et al.,* 2011; Carretta *et al.,* 2011; Falcone *et al.,* 2009; Falcone and Schorr, 2012, 2014; Jeffries *et al.,* 2003; Littnan, 2011; Martin and Kok, 2011; McCarthy *et al.,* 2011; McSweeney *et al.,* 2007; McSweeney *et al.,* 2009; Moore and Barlow, 2011; Tyack *et al.,* 2011; Southall *et al.,* 2012, 2013, 2014; Manzano-Roth *et al.,* 2013; DeRuiter *et al.,* 2013b; Goldbogen *et al.,* 2013; Moretti *et al.,* 2014; Smultea and Jefferson, 2014; Širović *et al.* 2015), including data developed in the series of 80+ reports submitted to NMFS, we believe that long-term consequences for individuals or populations are unlikely to result from Navy training activities in the Study Area.

Preliminary Determination

Training activities proposed in the GOA TMAA Study Area would result in mainly Level B and some Level A takes, as summarized in Tables 12 and 13. Based on best available science, NMFS concludes that exposures to marine mammal species and stocks due to GOA TMAA activities would result in individuals experiencing primarily short-term (temporary and short in duration) and relatively infrequent effects of the type or severity not expected to be additive. In addition, only a generally small portion of the stocks and species is likely to be exposed.

Marine mammal takes from Navy activities are not expected to impact annual rates of recruitment or survival and will therefore not result in population-level impacts for the following reasons:

- Most acoustic exposures (greater than 99 percent) would be within the non-injurious TTS or behavioral effects zones (Level B harassment consisting of generally temporary modifications in behavior) and none of the estimated exposures would result in mortality.
- As mentioned earlier, 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. For low frequency cetaceans (mysticetes) in the Study Area, most Level B exposures will occur at received levels less than 156 dB. The majority of estimated odontocete takes from MFAS/HFAS (at least for hull-mounted sonar, which is responsible for most of the sonar-related takes) also result from exposures to received levels less than 156 dB. Therefore, the majority of Level B takes are expected to be in the form of milder responses (*i.e.,* lower-level exposures that still rise to the level of a take, but would likely be in the less severe range of responses that qualify as a take), and are not expected to have deleterious impacts on the fitness of any individuals. Marine mammal densities inputted into the acoustic effects model are also conservative, particularly when considering species for which data in portions of the Study Area is limited, and when considering the seasonal migrations that extend throughout the Study Area.
- Acoustic disturbances caused by Navy sonar and explosives are short-term, intermittent, and (in the case of sonar) transitory. Even when an animal's exposure to active sonar may be more than one time, the intermittent nature of the sonar signal, the signal's low duty cycle (MFAS has a typical ping of every 50 seconds), and the fact that both the vessel and animal are moving, provide a very small chance that exposure to active sonar for individual animals and stocks would be repeated over extended periods of time. Consequently, we would not expect the Navy's activities to create conditions of long-term, continuous underwater noise leading to habitat abandonment or long-term hormonal or physiological stress responses in marine mammals.
- Range complexes where intensive training and testing have been occurring for decades have populations of multiple species with strong site fidelity (including highly sensitive resident beaked whales at some locations) and increases in the number of some species. Populations of beaked whales and other odontocetes in the Bahamas, and in other Navy fixed ranges that have been operating for tens of years, appear to be stable.
- Navy monitoring of Navy-wide activities since 2006 has documented hundreds of thousands of marine mammals on the range complexes and there are only two instances of overt behavioral change that have been observed.
- Navy monitoring of Navy-wide activities since 2006 has documented no demonstrable instances of injury to marine mammals as a result of non-impulsive acoustic sources.
- In at least three decades of similar Navy activities, only one instance of injury to marine mammals (March 25, 2011; three long-beaked common dolphin off Southern California) has occurred as a known result of training or testing using an impulsive source (underwater explosion). Of note, the time-delay firing underwater explosive training activity implicated in the March 4 incident is not proposed for the training activities in the GOA Study Area.
- The protective measures described in the Proposed Mitigation section above are designed to reduce vessel strike potential and avoid sound exposures that may cause serious injury, and to result in the least practicable adverse effect on marine mammal species or stocks.

Based on this analysis of the likely effects of the specified activity on marine mammals and their habitat, which includes consideration of the materials provided in the Navy's LOA application and GOA DSEIS/OEIS, and dependent upon the implementation of the mitigation and monitoring measures, NMFS finds that the total marine mammal take from the Navy's training and testing activities in the GOA Study Area will have a negligible impact on the affected marine mammal species or stocks. NMFS proposes to issue regulations for these activities in order to prescribe the means of effecting the least practicable adverse impact on marine mammal species or stocks and their habitat, and to set forth requirements pertaining to the monitoring and reporting of that taking.

Subsistence Harvest of Marine Mammals

There are no relevant subsistence uses of marine mammals implicated by this action. None of the proposed training activities in the Study Area occur where traditional Arctic subsistence hunting exists. Therefore, NMFS has preliminarily determined that the total taking affecting species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

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 Study Area: Blue whale, fin whale, humpback whale, sei whale, sperm whale, gray whale (Western North Pacific stock), North Pacific right whale, and Steller sea lion (Western U.S. stock). The Navy will consult with NMFS pursuant to section 7 of the ESA, and NMFS will also consult internally on the issuance of a LOA 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 a LOA.

NEPA

NMFS is a cooperating agency on the Navy's GOA DSEIS/OEIS, which was prepared and released to the public August 23, 2014. Upon completion, the GOA Final SEIS/OEIS will be made available for public review and posted on NMFS' Web site: *http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm*. NMFS intends to adopt the GOA Final SEIS/OEIS, if adequate and appropriate. Currently, we believe that the adoption of the GOA Final SEIS/OEIS will allow NMFS to meet its responsibilities under NEPA for the issuance of regulations and LOA for GOA TMAA. If the GOA SEIS/OEIS is deemed inadequate by NMFS, NMFS would supplement the existing analysis to ensure that we comply with NEPA prior to issuing the final rule and LOA.

Classification

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 would be affected by this rulemaking, and the Navy is not a small governmental jurisdiction, small organization, or small business, as defined by the RFA. Any requirements imposed by an LOA issued pursuant to these regulations, and any monitoring or reporting requirements imposed by these regulations, would be applicable only to the Navy. NMFS does not expect the issuance of these regulations or the associated LOA 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: February 17, 2016.

Samuel D. Rauch III,

Deputy Assistant Administrator for Regulatory Programs, National Marine Fisheries Service.

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

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

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

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

Subpart N—[Removed and Reserved]

■ 3. Remove and reserve subpart N, consisting of §§ 218.120 through 218.129.

■ 4. Subpart P is added to part 218 to read as follows:

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

Sec.

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

§ 218.150 Specified activity and specified geographical region.

(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 occurs incidental to the activities described in paragraph (c) of this section.

(b) The taking of marine mammals by the Navy is only authorized if it occurs within the GOA TMAA Study Area, 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 is only authorized if it occurs incidental to the following activities:

(1) Sonar and other Active Sources Used During Training:

(i) Mid-frequency (MF) Source Classes:

(A) MF1—an average of 541 hours per year.

(B) MF3—an average of 48 hours per year.

(C) MF4—an average of 53 hours per year.

(D) MF5—an average of 25 items per year.

(E) MF6—an average of 21 items per year.

(F) MF11—an average of 78 hours per year.

(ii) High-frequency (HF) Source Classes:

(A) HF1—an average of 24 hours per year.

(B) HF6—an average of 80 items per year.

(iii) Anti-Submarine Warfare (ASW) Source Classes:

(A) ASW2—an average of 80 hours per year.

(B) ASW3—an average of 546 hours per year.

(C) ASW4—an average 4 items per year.

(iv) Torpedoes (TORP):

(A) TORP2—an average of 5 items per year.

(B) [Reserved]

(2) Impulsive Source Detonations During Training:

(i) Explosive Classes:

(A) E5 (>5 to 10 pound [lb] net explosive weight (NEW))—an average of 112 detonations per year.

(B) E6 (>10 to 20 lb NEW)—an average of 2 detonations per year.

(C) E7 (>20 to 60 lb NEW)—an average of 4 detonations per year.

(D) E8 (>60 to 100 lb NEW)—an average of 6 detonations per year.

(E) E9 (>100 to 250 lb NEW)—an average of 142 detonations per year.

(F) E10 (>250 to 500 lb NEW)—an average of 32 detonations per year.

(G) E11 (>500 to 650 lb NEW)—an average of 2 detonations per year.

(H) E12 (>650 to 1,000 lb NEW)—an average of 4 detonations per year.

(ii) [Reserved]

§ 218.151 Effective dates.

Regulations in this subpart are effective May 4, 2016, through May 3, 2021.

§ 218.152 Permissible methods of taking.

(a) Under letter of authorization (LOA) issued pursuant to §§ 216.106 and 218.157 of this chapter, the holder of the LOA may incidentally, but not intentionally, take marine mammals within the area described in § 218.150, provided the activity is in compliance with all terms, conditions, and requirements of these regulations and the LOA.

(b) The activities identified in § 218.150(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 § 218.150(c) is limited to the following species, by the identified method of take and the indicated number of times:

(1) Level B Harassment for all Training Activities:

(i) Mysticetes:

(A) Blue whale (*Balaenoptera musculus*), Eastern North Pacific—475 (an average of 95 per year).

(B) Fin whale (*Balaenoptera physalus*), Northeast Pacific—12,910 (an average of 2,582 per year).

(C) Humpback whale (*Megaptera novaeangliae*), Central North Pacific—645 (an average of 129 per year).

(D) Humpback whale (*Megaptera novaeangliae*), Western North Pacific—50 (an average of 10 per year).

(E) Minke whale (*Balaenoptera acutorostrata*), Alaska—435 (an average of 87 per year).

(F) North Pacific right whale (*Eubalaena japonica*), Eastern North Pacific—35 (an average of 7 per year).

(G) Sei whale (*Balaenoptera borealis*), Eastern North Pacific—65 (an average of 13 per year).

(ii) Odontocetes:

(A) Baird's beaked whale (*Berardius bairdii*), Alaska—2,005 (an average of 401 per year).

(B) Cuvier's beaked whale (*Ziphius cavirostris*), Alaska—12,720 (an average of 2,544 per year).

(C) Dall's porpoise (*Phocoenoidea dalli*), Alaska—81,220 (an average of 16,244 per year).

(D) Harbor porpoise (*Phocoena phocoena*), GOA—27,420 (an average of 5,484 per year).

(E) Harbor porpoise (*Phocoena phocoena*), Southeast Alaska—9,630 (an average of 1,926 per year).

(F) Killer whale (*Orcinus orca*), Alaska Resident—2,820 (an average of 564 per year).

(G) Killer whale (*Orcinus orca*), Eastern North Pacific Offshore—265 (an average of 53 per year).

(H) Killer whale (*Orcinus orca*), AT1 Transient—5 (an average of 1 per year).

(I) Killer whale (*Orcinus orca*), GOA, Aleutian Island, and Bearing Sea Transient—720 (an average of 144 per year).

(J) Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), North Pacific—9,815 (an average of 1,963 per year).

(K) Stejneger's beaked whale (*Mesoplodon stejnegeri*), Alaska—5,765 (an average of 1,153 per year).

(L) Sperm whale (*Physeter macrocephalus*), North Pacific—985 (an average of 197 per year).

(iii) Pinnipeds:

(A) California sea lion (*Zalophus californianus*), U.S.—25 (an average of 5 per year).

(B) Steller sea lion (*Eumetopias jubatus*), Eastern U.S.—3,355 (an average of 671 per year).

(C) Steller sea lion (*Eumetopias jubatus*), Western U.S.—2,860 (an average of 572 per year).

(D) Harbor seal (*Phoca vitulina*), North Kodiak—5 (an average of 1 per year).

(E) Harbor seal (*Phoca vitulina*), South Kodiak—5 (an average of 1 per year).

(F) Harbor seal (*Phoca vitulina*), Prince William Sound—10 (an average of 2 per year).

(G) Northern elephant seal (*Mirounga angustirostris*), California Breeding—1,225 (an average of 245 per year).

(H) Northern fur seal (*Callorhinus ursinus*), Eastern Pacific—7,140 (an average of 1,428 per year).

(2) Level A Harassment for all Training Activities:

(i) Odontocetes:

(A) Dall's porpoise (*Phocoenoidea dalli*), Alaska—25 (an average of 5 per year).

(B) [Reserved]

(ii) [Reserved]

§ 218.153 Prohibitions.

Notwithstanding takings contemplated in § 218.152 and authorized by an LOA issued under §§ 216.106 and 218.157 of this chapter, no person in connection with the activities described in § 218.150 may:

(a) Take any marine mammal not specified in § 218.152(c);

(b) Take any marine mammal specified in § 218.152(c) other than by incidental take as specified in § 218.152(c);

(c) Take a marine mammal specified in § 218.152(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 an LOA issued under §§ 216.106 and 218.157 of this chapter.

§ 218.154 Mitigation.

(a) When conducting training activities, as identified in § 218.150, the mitigation measures contained in the LOA issued under §§ 216.106 and 218.157 of this chapter must be implemented. These mitigation measures include, but are not limited to:

(1) *Lookouts.*The Navy shall have two types of lookouts for the purposes of conducting visual observations: Those positioned on ships; and those positioned ashore, in aircraft, or on boats. The following are protective measures concerning the use of lookouts.

(i) Lookouts positioned on surface ships shall be dedicated solely to diligent observation of the air and surface of the water. Their observation objectives shall include, but are not limited to, detecting the presence of biological resources and recreational or fishing boats, observing mitigation zones, and monitoring for vessel and personnel safety concerns.

(ii) Due to manning and space restrictions on aircraft, small boats, and some Navy ships, lookouts for these platforms may be supplemented by the aircraft crew or pilot, boat crew, range site personnel, or shore-side personnel. Lookouts positioned in minimally manned platforms may be responsible for tasks in addition to observing the air or surface of the water (*e.g.,* navigation of a helicopter or small boat). However, all lookouts shall, considering personnel safety, practicality of implementation, and impact on the effectiveness of the activity, comply with the observation objectives described above for lookouts positioned on ships.

(iii) All personnel standing watch on the bridge, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare helicopter crews, civilian equivalents, and lookouts shall successfully complete the United States Navy Marine Species Awareness Training prior to standing watch or serving as a lookout.

(iv) Lookout measures for non-impulsive sound:

(A) With the exception of vessels less than 65 ft (20 m) in length, ships using hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare activities at sea shall have two Lookouts at the forward position of the vessel.

(B) While using hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare activities at sea, vessels less than 65 ft (20 m) in length shall have one lookout at the forward position of the vessel due to space and manning restrictions.

(C) During non-hull mounted mid-frequency active sonar training activities, Navy aircraft participating in exercises at sea shall conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Helicopters shall observe/survey the vicinity of an anti-submarine warfare training event for 10 minutes before the first deployment of active (dipping) sonar in the water.

(D) Ships or aircraft conducting non-hull-mounted mid-frequency active sonar, such as helicopter dipping sonar systems, shall maintain one lookout.

(E) Ships conducting high-frequency active sonar shall maintain one lookout.

(v) Lookout measures for explosives and impulsive sound:

(A) Aircraft conducting explosive signal underwater sound buoy activities using >0.5–2.5 lb. NEW shall have one lookout.

(B) Surface vessels or aircraft conducting small-, medium-, or large-caliber gunnery exercises against a surface target shall have one lookout. From the intended firing position, trained lookouts shall survey the mitigation zone for marine mammals prior to commencement and during the exercise as long as practicable. Towing vessels, if applicable, shall also maintain one lookout. 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.

(C) Aircraft conducting explosive bombing exercises shall have one lookout and any surface vessels involved shall have trained Lookouts. If surface vessels are involved, lookouts shall survey for floating kelp and marine mammals. 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. (460 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: Aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

(D) When aircraft are conducting missile exercises against a surface target, the Navy shall have one Lookout positioned in an aircraft. 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 slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas.

(E) Ships conducting explosive and non-explosive gunnery exercises shall have one Lookout on the ship. This may be the same lookout described in paragraph (B) above for surface vessels conducting small-, medium-, or large-caliber gunnery exercises when that activity is conducted from a ship against a surface target.

(F) During sinking exercises, two Lookouts shall be used. One lookout shall be positioned in an aircraft and one lookout shall be positioned on a vessel.

(vi) Lookout measures for physical strike and disturbance:

(A) While underway, surface ships shall have at least one lookout.

(B) [Reserved]

(vii) Lookout measures for non-explosive practice munitions:

(A) Gunnery exercises using non-explosive practice munitions (*e.g.,* small-, medium-, and large-caliber) using a surface target shall have one lookout.

(B) During non-explosive bombing exercises one lookout shall be positioned in an aircraft and trained lookouts shall be positioned in any surface vessels involved.

(C) When aircraft are conducting non-explosive missile exercises (including exercises using rockets) against a surface target, the Navy shall have one lookout positioned in an aircraft.

(2) Mitigation Zones—The following are protective measures concerning the implementation of mitigation zones.

(i) Mitigation zones shall be measured as the radius from a source and represent a distance to be monitored.

(ii) Visual detections of marine mammals or sea turtles within a mitigation zone shall be communicated immediately to a watch station for information dissemination and appropriate action.

(iii) Mitigation zones for non-impulsive sound:

(A) The Navy shall ensure that hull-mounted mid-frequency active sonar transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals or sea turtles are within 1,000 yd. (914 m) of the sonar dome (the bow).

(B) The Navy shall ensure that hull-mounted mid-frequency active sonar transmissions are limited to at least 10 dB below the equipment's normal operating level if any detected marine mammals or sea turtles are within 500 yd. (457 m) of the sonar dome.

(C) The Navy shall ensure that hull-mounted mid-frequency active sonar transmissions are ceased if any detected cetaceans or sea turtles are within 200 yd. (183 m) and pinnipeds are within 100 yd. (90 m) of the sonar dome. Transmissions shall not resume until the marine mammal has been observed exiting the mitigation zone, is thought to have exited the mitigation zone based on its course and speed, has not been detected for 30 minutes, the vessel has transited more than 2,000 yd. beyond the location of the last detection, or the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave (and there are no other marine mammal sightings within the mitigation zone). Active transmission may resume when dolphins are bow riding because they are out of the main transmission axis of the active sonar while in the shallow-wave area of the ship bow.

(D) The Navy shall ensure that high-frequency and non-hull-mounted mid-frequency active sonar transmission levels are ceased if any detected cetaceans are within 200 yd. (180 m) and pinnipeds are within 100 yd. (90 m) of the source. Transmissions shall not resume until the marine mammal has been observed exiting the mitigation zone, is thought to have exited the mitigation zone based on its course and speed, the mitigation zone has been clear from any additional sightings for a period of 10 minutes for an aircraft-deployed source, the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a vessel-deployed source, the vessel or aircraft has repositioned itself more than 400 yd. (370 m) away from the location of the last sighting, or the vessel concludes that dolphins are deliberately closing in to ride the vessel's bow wave (and there are no other marine mammal sightings within the mitigation zone).

(iv) Mitigation zones for explosive and impulsive sound:

(A) A mitigation zone with a radius of 350 yd. (320 m) shall be established for explosive signal underwater sonobuoys using >0.5 to 2.5 lb NEW. Explosive signal underwater sonobuoys shall not be deployed if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone (around the intended deployment location). Explosive signal underwater sonobuoy deployment shall cease if a marine mammal is sighted within the mitigation zone. Detonations shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes. Passive acoustic monitoring shall also be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft in order to increase vigilance of their visual surveillance.

(B) A mitigation zone with a radius of 200 yd. (180 m) shall be established for small- and medium-caliber gunnery exercises with a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing ship, or the intended target location has been repositioned more than 400 yd. (370 m) away from the location of the last sighting.

(C) A mitigation zone with a radius of 600 yd. (549 m) shall be established for large-caliber gunnery exercises with a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

(D) A mitigation zone with a radius of 900 yd. (823 m) shall be established for missile exercises with up to 250 lb NEW and a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

(E) A mitigation zone with a radius of 2,000 yd. (1.8 km) shall be established for missile exercises with 251 to 500 lb NEW using a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

(F) A mitigation zone with a radius of 2,500 yd. (2.3 km) around the intended impact location for explosive bombs and 1000 yd. (920 m) for non-explosive bombs shall be established for bombing exercises. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Bombing shall cease if a marine mammal is sighted within the mitigation zone. Bombing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

(G) A mitigation zone with a radius of 2.5 nautical miles shall be established for sinking exercises. Sinking exercises shall include aerial observation beginning 90 minutes before the first firing, visual observations from vessels throughout the duration of the exercise, and both aerial and vessel observation immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours. Prior to conducting the exercise, the Navy shall review remotely sensed sea surface temperature and sea surface height maps to aid in deciding where to release the target ship hulk. The Navy shall also monitor using passive acoustics during the exercise. Passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to lookouts posted in aircraft and on vessels in order to increase vigilance of their visual surveillance. Lookouts shall also increase observation vigilance before the use of torpedoes or unguided ordnance with a NEW of 500 lb. or greater, or if the Beaufort sea state is a 4 or above. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. The exercise shall cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. The exercise shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or the mitigation zone has been clear from any additional sightings for a period of 30 minutes. Upon sinking the vessel, the Navy shall conduct post-exercise visual surveillance of the mitigation zone for 2 hours (or until sunset, whichever comes first).

(H) A mitigation zone of 70 yd. (46 m) shall be established for all explosive large-caliber gunnery exercises conducted from a ship. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, the mitigation zone has been clear from any additional sightings for a period of 30 minutes, or the vessel has repositioned itself more than 140 yd. (128 m) away from the location of the last sighting.

(v) Mitigation zones for vessels and in-water devices:

(A) A mitigation zone of 500 yd. (460 m) for observed whales and 200 yd (183 m) for all other marine mammals (except bow riding dolphins) shall be established for all vessel movement during training activities, providing it is safe to do so.

(B) A mitigation zone of 250 yd. (229 m) shall be established for all towed in-water devices, providing it is safe to do so.

(vi) Mitigation zones for non-explosive practice munitions:

(A) A mitigation zone of 200 yd. (180 m) shall be established for small, medium, and large caliber gunnery exercises using a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing ship, or the intended target location has been repositioned more than 400 yd. (370 m) away from the location of the last sighting.

(B) A mitigation zone of 1,000 yd. (920 m) shall be established for bombing exercises. Bombing shall cease if a marine mammal is sighted within the mitigation zone. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Bombing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

(C) A mitigation zone of 900 yd. (823 m) shall be established for missile exercises (including rockets) using a surface target. The exercise shall not commence if concentrations of floating vegetation (kelp paddies) are observed in the mitigation zone. Firing shall cease if a marine mammal is sighted within the mitigation zone. Firing shall recommence if any one of the following conditions is met: The animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on its course and speed, or the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

(3) *Stranding response plan.* (i) The Navy shall abide by the letter of the ''Stranding Response Plan for Major Navy Training Exercises in the GOA TMAA Study Area,'' to include the following measures:

(A) *Shutdown procedures.* When an Uncommon Stranding Event (USE) occurs during a Major Training Exercise (MTE) in the Study Area, the Navy shall implement the procedures described below:

(*1*) The Navy shall implement a shutdown when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the GOA TMAA Study Area Stranding Communication Protocol that a USE involving live animals has been identified and that at least one live animal is located in the water. NMFS and the Navy shall maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(*2*) 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).

(*3*) If the Navy finds an injured or dead animal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s), including carcass condition if the animal(s) is/are dead, location, time of first discovery, observed behavior (if alive), and photo or video (if available). Based on the information provided, NFMS shall determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(*4*) 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 mid-frequency active sonar training activities or explosive detonations, though farther than 14 nautical miles from the distressed animal(s), is likely contributing to the animals' refusal to return to the open water. If so, NMFS and the Navy shall further coordinate to determine what measures are necessary to improve the probability that the animals will return to open water and implement those measures as appropriate.

(B) Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the GOA TMAA Study Area Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using mid-frequency active sonar, and marine mammal sightings information associated with training activities occurring within 80 nautical miles (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80-nautical miles (148–km), 72–hour period prior to the event shall be provided as soon as it becomes available. The Navy shall provide NMFS investigative teams with additional relevant unclassified information as requested, if available.

(ii) [Reserved]

(b) [Reserved]

§ 218.155 Requirements for monitoring and reporting.

(a) The Holder of the Authorization must notify NMFS immediately (or as soon as operational security considerations allow) if the specified activity identified in § 218.150 is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in § 218.152(c).

(b) The Holder of the LOA must conduct all monitoring and required reporting under the LOA, including abiding by the GOA TMAA monitoring plan.

(c) *General notification of injured or dead marine mammals.* Navy personnel shall ensure that NMFS (regional stranding coordinator) is notified immediately (or as soon as operational security considerations allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of, a Navy training activity utilizing mid- or high-frequency active sonar, or underwater explosive detonations. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). 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.

(d) *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 unknown), and the time of the strike.

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

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

(4) Provide NMFS a photo or video, if equipment is available.

(5) Within 2 weeks of the strike, provide NMFS with a detailed description of the specific actions of the vessel in the 30–minute timeframe immediately preceding the strike, during the event, and immediately after the strike (*e.g.,* the speed and changes in speed, the direction and changes in direction, other maneuvers, sonar use, etc., if not classified); a narrative description of marine mammal sightings during the event and immediately after, and any information as to sightings prior to the strike, if available; and use established Navy shipboard procedures to make a camera available to attempt to capture photographs following a ship strike.

(e) *Communication plan.* The Navy and NMFS shall develop a communication plan that will include all of the communication protocols (phone trees, etc.) and associated contact information required for NMFS and the Navy to carry out the necessary expeditious communication required in the event of a stranding or ship strike, including information described in the proposed notification measures above.

(f) *Annual GOA TMAA monitoring report.* The Navy shall submit an annual report of the GOA TMAA monitoring describing the implementation and results from the previous calendar year. Data collection methods shall be standardized across range complexes and study areas to allow for comparison in different geographic locations. Although additional information will be gathered, the protected species observers collecting marine mammal data pursuant to the GOA TMAA monitoring plan shall, at a minimum, provide the same marine mammal observation data required in § 218.155. The report shall be submitted either 90 days after the calendar year, or 90 days after the conclusion of the monitoring year to be determined by the Adaptive Management process. The GOA TMAA Monitoring Report may be provided to NMFS within a larger report that includes the required Monitoring Plan reports from multiple range complexes and study areas (the multi-Range Complex Annual Monitoring Report). Such a report would describe progress of knowledge made with respect to monitoring plan study questions across all Navy ranges associated with the Integrated Comprehensive Monitoring Program. Similar study questions shall be treated together so that progress on each topic shall be summarized across all Navy ranges. The report need not include analyses and content that does not provide direct assessment of cumulative progress on the monitoring plan study questions.

(g) *Annual GOA TMAA exercise reports.* Each year, the Navy shall submit a preliminary report detailing the status of authorized sound sources within 21 days after the anniversary of the date of issuance of the LOA. Each year, the Navy shall submit a detailed report within 3 months after the anniversary of the date of issuance of the LOA. The annual report shall contain information on Major Training Exercises (MTEs), Sinking Exercise (SINKEX) events, and a summary of all sound sources used, as described in paragraph (g)(3) of this section. The analysis in the detailed report shall be based on the accumulation of data from the current year's report and data collected from previous the report. The detailed reports shall contain information identified in paragraphs (g)(1) through (4) of this section.

(1) MFAS/HFAS Major Training Exercises—This section shall contain the following information for Major Training Exercises conducted in the GOA TMAA:

(i) Exercise Information (for each MTE):

(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 lookouts.

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

(I) Total hours of each active sonar source bin.

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

(ii) Individual marine mammal sighting information for each sighting in each exercise when mitigation occurred:

(A) Date/Time/Location of sighting.

(B) Species (if not possible, indication of whale/dolphin/pinniped).

(C) Number of individuals.

(D) Initial Detection Sensor.

(E) Indication of specific type of platform observation made from (including, for example, what type of surface vessel or testing platform).

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

(G) Sea state.

(H) Visibility.

(I) Sound source in use at the time of sighting.

(J) Indication of whether animal is <200 yd, 200 to 500 yd, 500 to 1,000 yd, 1,000 to 2,000 yd, or >2,000 yd from sonar source.

(K) *Mitigation implementation.* Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was.

(L) If source in use 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).

(M) *Observed behavior.* Lookouts 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.) and if any calves present.

(iii) An evaluation (based on data gathered during all of the MTEs) of the effectiveness of mitigation measures designed to minimize the received level to which marine mammals may be exposed. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) *SINKEXs.* This section shall include the following information for each SINKEX completed that year:

(i) Exercise information (gathered for each SINKEX):

(A) Location.

(B) Date and time exercise began and ended.

(C) Total hours of observation by lookouts before, during, and after exercise.

(D) Total number and types of explosive source bins 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).

(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 (by Navy lookouts) information (gathered for each marine mammal sighting) for each sighting in each exercise that required mitigation to be implemented:

(A) Date/Time/Location of sighting.

(B) Species (if not possible, indicate whale, dolphin, or pinniped).

(C) Number of individuals.

(D) Initial detection sensor.

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

(F) Sea state.

(G) Visibility.

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

(I) Distance of marine mammal from actual detonations (or target spot if not yet detonated).

(J) *Observed behavior.* Lookouts shall report, in plain language and without trying to categorize in any way, the observed behavior of the animal(s) (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction and if any calves present.

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

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

(3) Summary of sources used.

(i) This section shall include the following information summarized from the authorized sound sources used in all training events:

(A) Total annual hours or quantity (per the LOA) of each bin of sonar or other non-impulsive source;

(B) Total annual number of each type of explosive exercises (of those identified as part of the ''Specified Activity'' in this proposed rule) and total annual expended/detonated rounds (missiles, bombs, sonobuoys, etc.) for each explosive bin.

(4) *Geographic information presentation.* The reports shall present an annual (and seasonal, where practical) depiction of training exercises and testing bin usage geographically across the Study Area.

(g) *Sonar exercise notification.* The Navy shall submit to NMFS (contact as specified in the LOA) an electronic report within fifteen calendar days after the completion of any major training exercise indicating:

(i) Location of the exercise.

(ii) Beginning and end dates of the exercise.

(iii) Type of exercise.

(h) *Five-year close-out exercise report.* This report shall be included as part of the 2021 annual exercise report. This report shall provide the annual totals for each sound source bin with a comparison to the annual allowance and the 5-year total for each sound source bin with a comparison to the 5-year allowance. Additionally, if there were any changes to the sound source allowance, this report shall include a discussion of why the change was made and include the analysis to support how the change did or did not result in a change in the SEIS and final rule determinations. The report shall be submitted 3 months after the expiration of this subpart. NMFS shall submit comments on the draft close-out report, if any, within 3 months of receipt. The report shall be considered final after the Navy has addressed NMFS' comments, or 3 months after the submittal of the draft if NMFS does not provide comments.

§ 218.156 Applications for letters of authorization (LOA).

To incidentally take marine mammals pursuant to the regulations in this subpart, the U.S. citizen (as defined by § 216.106 of this chapter) conducting the activity identified in § 218.150(c) (the U.S. Navy) must apply for and obtain either an initial LOA in accordance with § 218.157 or a renewal under § 218.158.

§ 218.157 Letters of authorization (LOA).

(a) An LOA, unless suspended or revoked, shall be valid for a period of time not to exceed the period of validity of this subpart.

(b) Each LOA 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 LOA shall be based on a determination that the total number of marine mammals taken by the activity as a whole shall have no more than a negligible impact on the affected species or stock of marine mammal(s).

§ 218.158 Renewals and modifications of letters of authorization (LOA) and adaptive management.

(a) A letter of authorization issued under §§ 216.106 and 218.157 of this chapter for the activity identified in § 218.150(c) shall be renewed or modified upon request of the applicant, provided that:

(1) The proposed specified activity and mitigation, monitoring, and reporting measures, as well as the anticipated impacts, are the same as those described and analyzed for these regulations (excluding changes made pursuant to the adaptive management provision of this chapter), and;

(2) NMFS determines that the mitigation, monitoring, and reporting measures required by the previous LOA under these regulations were implemented.

(b) For LOA modification or renewal requests by the applicant that include changes to the activity or the mitigation, monitoring, or reporting (excluding changes made pursuant to the adaptive management provision of this chapter) that do not change the findings made for the regulations or result in no more than a minor change in the total estimated number of takes (or distribution by species or years), NMFS may publish a notice of proposed LOA in the **Federal Register**, including the associated analysis illustrating the change, and solicit public comment before issuing the LOA.

(c) A LOA issued under § 216.106 and § 218.157 of this chapter for the activity identified in § 218.154 of this chapter may be modified by NMFS under the following circumstances:

(1) *Adaptive management.* NMFS may modify and augment the existing mitigation, monitoring, or reporting 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 the mitigation and monitoring.

(i) Possible sources of data that could contribute to the decision to modify the mitigation, monitoring, and reporting measures in an LOA:

(A) Results from Navy's monitoring from the previous year(s);

(B) Results from other marine mammal and/or sound research or studies; or

(C) Any information that reveals marine mammals may have been taken in a manner, extent, or number not authorized by these regulations or subsequent LOA.

(ii) If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS would publish a notice of proposed LOA in the **Federal Register** and solicit public comment.

(2) *Emergencies.* If NMFS determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in § 218.152(c), an LOA may be modified without prior notification and an opportunity for public comment. Notification would be published in the **Federal Register** within 30 days of the action.

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