DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 218

[Docket No. 220726–0163]

RIN 0648–BK46

Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to the U.S. Navy Training Activities in the Gulf of Alaska Study 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) to take marine mammals incidental to training activities conducted in the Gulf of Alaska (GOA) Study Area (hereafter referred to as the GOA Study Area). Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue regulations and a subsequent Letter of Authorization (LOA) to the Navy to incidentally take marine mammals during the specified activities. NMFS will consider public comments prior to issuing any final rule and making final decisions on the issuance of the requested LOA. Agency responses to public comments will be provided in the notice of the final decision. The Navy's activities qualify as military readiness activities pursuant to the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (2004 NDAA).

DATES: Comments and information must be received no later than September 26, 2022.

ADDRESSES: Submit all electronic public comments via the Federal e-Rulemaking Portal. Go to *https://www.regulations.gov* and enter NOAA–NMFS–2022–0060 in the Search box. Click on the ''Comment'' icon, complete the required fields, and enter or attach your comments.

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), 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.

A copy of the Navy's application and other supporting documents and documents cited herein may be obtained online at: *https://www.fisheries.noaa.gov/action/incidental-take-authorization-us-navy-training-activities-gulf-alaska-temporary-maritime-0.* In case of problems accessing these documents, please use the contact listed here (see **FOR FURTHER INFORMATION CONTACT**).

FOR FURTHER INFORMATION CONTACT: Leah Davis, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Purpose of Regulatory Action

These proposed regulations, issued under the authority of the MMPA (16 U.S.C. 1361 *et seq.*), would provide the framework for authorizing the take of marine mammals incidental to the Navy's training activities (which qualify as military readiness activities), including the use of sonar and other transducers, and in-air detonations at or near the surface (within 10 m above the water surface) in the GOA Study Area. The GOA Study Area is comprised of three areas: the Temporary Maritime Activities Area (TMAA), a warning area, and the Western Maneuver Area (WMA) (see Figure 1). The TMAA and WMA are temporary areas established within the GOA for ships, submarines, and aircraft to conduct training activities. The warning area overlaps and extends slightly beyond the northern corner of the TMAA. The WMA is located south and west of the TMAA and provides additional surface, sub-surface, and airspace in which to maneuver in support of activities occurring within the TMAA. The use of sonar and other transducers, and explosives would not occur within the WMA.

NMFS received an application from the Navy requesting 7-year regulations and an authorization to incidentally take individuals of multiple species of marine mammals (''Navy's rulemaking/LOA application'' or ''Navy's application''). Take is anticipated to occur by Level A harassment and Level B harassment incidental to the Navy's training activities. No lethal take is anticipated or proposed for authorization.

Background

The MMPA prohibits the ''take'' of marine mammals, with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA direct the Secretary of Commerce (as delegated to NMFS) 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 proposed or, if the taking is limited to harassment, the public is provided with notice of the proposed incidental take authorization and provided the opportunity to review and submit comments.

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stocks and will not have an unmitigable adverse impact on the availability of the species or stocks for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other means of effecting the least practicable adverse impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stocks for taking for certain subsistence uses (referred to in this rule as ''mitigation measures''); and requirements pertaining to the monitoring and reporting of such takings. The MMPA defines ''take'' to mean to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. The Preliminary Analysis and Negligible Impact Determination section below discusses the definition of ''negligible impact.''

The NDAA for Fiscal Year 2004 (2004 NDAA) (Pub. L. 108–136) amended section 101(a)(5) of the MMPA to remove the ''small numbers'' and ''specified geographical region'' provisions indicated above and amended the definition of ''harassment'' as applied to a ''military readiness activity.'' The definition of harassment for military readiness activities (Section 3(18)(B) of the MMPA) is (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). In addition, the 2004 NDAA amended the MMPA as it relates to military readiness activities such that the least practicable adverse impact analysis shall include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

More recently, Section 316 of the NDAA for Fiscal Year 2019 (2019 NDAA) (Pub. L. 115–232), signed on August 13, 2018, amended the MMPA to allow incidental take rules for military readiness activities under section 101(a)(5)(A) to be issued for up to 7 years. Prior to this amendment, all incidental take rules under section 101(a)(5)(A) were limited to 5 years.

Summary and Background of Request

On October 9, 2020, NMFS received an adequate and complete application from the Navy requesting authorization for take of marine mammals, by Level A harassment and Level B harassment, incidental to training from the use of active sonar and other transducers and explosives (in-air, occurring at or above the water surface) in the TMAA over a 7-year period beginning when the current authorization expires. On March 12, 2021, the Navy submitted an updated application that provided revisions to the Northern fur seal take estimate and incorporated additional best available science. In August 2021, the Navy communicated to NMFS that it was considering an expansion of the GOA Study Area and an expansion of the Portlock Bank Mitigation Area proposed in its previous applications. On February 2, 2022, the Navy submitted a second updated application that described the addition of the WMA to the GOA Study Area (which previously just consisted of the TMAA) and the replacement of the Portlock Bank Mitigation Area with the Continental Shelf and Slope Mitigation Area. The Navy is not planning to conduct any testing activities.

On January 8, 2021 (86 FR 1483), we published a notice of receipt (NOR) of application in the **Federal Register**, requesting comments and information related to the Navy's request for 30 days. We received one comment on the NOR that was non-substantive in nature.

The following types of training, which are classified as military readiness activities pursuant to the MMPA, as amended by the 2004 NDAA, would be covered under the regulations and LOA (if issued): surface warfare (detonations at or above the water surface) and anti-submarine warfare (sonar and other transducers). The Navy is also conducting Air Warfare, Electronic Warfare, Naval Special Warfare, Strike Warfare, and Support Operations, but these activities do not involve sonar and other transducers, detonations at or above the water surface, or any other stressors that could result in the take of marine mammals. (See the 2020 GOA Draft SEIS/OEIS for more detail on those activities). The activities would not include in-water explosives, pile driving/removal, or use of air guns.

This would be the third time NMFS has promulgated incidental take regulations pursuant to the MMPA relating to similar military readiness activities in the GOA, following those effective beginning May 4, 2011 (76 FR 25479; May 4, 2011) and April 26, 2017 (82 FR 19530; April 27, 2017).

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. 8062), which requires the readiness of the naval forces of the United States. 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 (OPAREA), and airspace needed to develop and maintain skills for conducting naval activities.

The Navy has conducted training activities in the TMAA portion of the GOA Study Area since the 1990s. Since the 1990s, the Department of Defense has conducted a major joint training exercise in Alaska and off the Alaskan coast that involves the Departments of the Navy, Army, Air Force, and Coast Guard participants reporting to a unified or joint commander who coordinates the activities. These activities are planned to demonstrate and evaluate the ability of the services to engage in a conflict and successfully carry out plans in response to a threat to national security. The Navy's planned activities for the period of this proposed rule would be a continuation of the types and level of training activities that have been ongoing for more than a decade. While the specified activities have not changed, there are changes in the platforms and systems used in those activities, as well as changes in the bins (source classifications) used to analyze the activities. (For example, two new sonar bins were added (MF12 and ASW1) and another bin was eliminated (HF6). This was due to changes in platforms and systems.) Further, the Navy expanded the GOA Study Area to include the WMA, though the vast majority of the training activities would still occur only in the TMAA.

The Navy's rulemaking/LOA application reflects the most up-to-date compilation of training activities deemed necessary by senior Navy leadership to accomplish military readiness requirements. The types and numbers of activities included in the proposed rule account for fluctuations in training in order to meet evolving or emergent military readiness requirements. These proposed regulations would become effective in December of 2022 and would cover training activities that would occur for a 7-year period following the expiration of the current MMPA authorization for the GOA, which expired on April 26, 2022.

Description of the Specified Activity

The Navy requests authorization to take marine mammals incidental to conducting training activities. The Navy has determined that acoustic and explosives stressors are most likely to result in impacts on marine mammals that could rise to the level of harassment, and NMFS concurs with this determination. Detailed descriptions of these activities are provided in Chapter 2 of the 2020 GOA Draft Supplemental Environmental Impact Statement (SEIS)/Overseas EIS (OEIS) (2020 GOA DSEIS/OEIS) (*https://www.goaeis.com/*) and in the Navy's rulemaking/LOA application (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-us-navy-training-activities-gulf-alaska-temporary-maritime-0*) and are summarized here.

Dates and Duration

Training activities would be conducted intermittently in the GOA Study Area over a maximum time period of up to 21 consecutive days annually from April to October to support a major joint training exercise in Alaska and off the Alaskan coast that involves the Departments of the Navy, Army, Air Force, and Coast Guard. The 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 specified activities would occur over a maximum time period of up to 21 consecutive days each year during the 7-year period of validity of the regulations. The proposed number of training activities are described in the Detailed Description of Proposed Activities section (Table 3) of this proposed rule.

Geographical Region

The GOA Study Area (see Figure 1 below and Figure ES–1 of the 2022 Supplement to the 2020 GOA DSEIS/OEIS) is entirely at sea and is comprised of the TMAA and a warning area in the Gulf of Alaska, and the WMA. The term ''at-sea'' refers to training activities in the Study Area (both the TMAA and WMA) 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 Study Area are not included in this proposed rule, and are covered under separate environmental documentation prepared by the U.S. Air Force and the U.S. Army. As depicted in Figure 1 of this proposed rule, the TMAA is a polygon roughly resembling a rectangle oriented from northwest to southeast, approximately 300 nmi (556 km) in length by 150 nmi (278 km) in width, located south of Montague Island and east of Kodiak Island. The GOA Study Area boundary was intentionally designed to avoid ESA-designated Steller sea lion critical habitat. The WMA is located south and west of the TMAA, and provides an additional 185,806 nmi^2 of surface, sub-surface, and airspace training to support activities occurring within the TMAA (Figure 1). The boundary of the WMA follows the bottom of the slope at the 4,000 m contour line, and was configured to avoid overlap and impacts to ESA-designated critical habitat, biologically important areas (BIAs), migration routes, and primary fishing grounds. The WMA provides additional airspace and sea space for aircraft and vessels to maneuver during training activities for increased training complexity. The TMAA and WMA are temporary areas established within the GOA for ships, submarines, and aircraft to conduct training activities.

Additional detail can be found in Chapter 2 of the Navy's rulemaking/LOA application.

BILLING CODE 3510–22–P

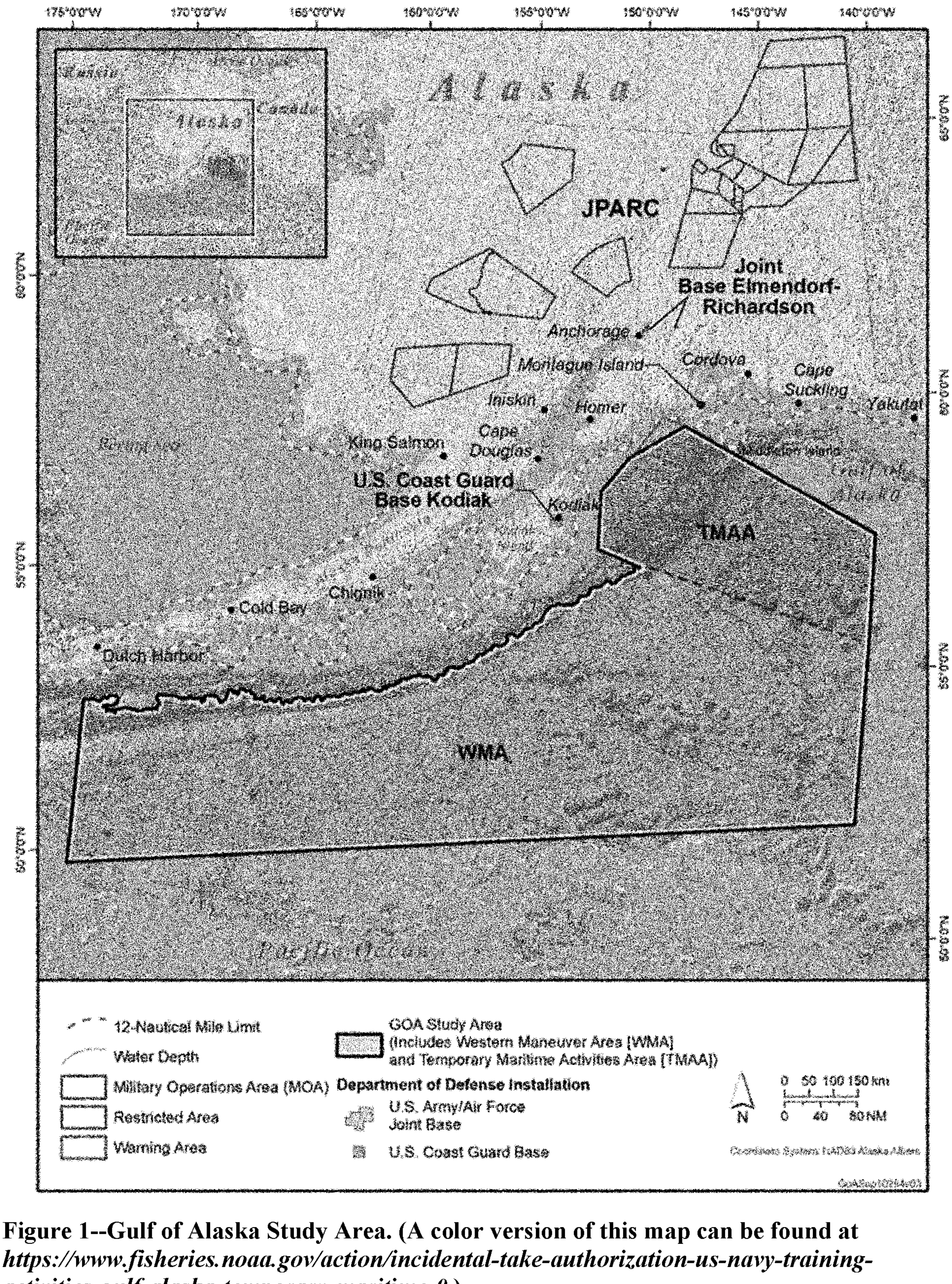

Figure 1--Gulf of Alaska Study Area. (A color version of this map can be found at *https://www.fisheries.noaa.gov/action/incidental-take-authorization-us-navy-training-activities-gulf-alaska-temporary-maritime-0*.)

BILLING CODE 3510–22–C

Primary Mission Areas

The Navy categorizes many of its training activities into functional warfare areas called primary mission areas. The Navy's planned activities for the GOA Study Area generally fall into the following six primary mission areas: Air Warfare; Surface Warfare; Anti-Submarine Warfare; Electronic Warfare; Naval Special Warfare; and Strike Warfare. Most activities conducted in the GOA are categorized under one of these primary mission areas; activities that do not fall within one of these areas are listed as ''support operations'' or ''other training activities.'' Each warfare community (aviation, surface, and subsurface) may train in some or all of these primary mission areas. A description of the sonar, munitions, targets, systems, and other materials used during training activities within these primary mission areas is provided in Appendix A (*Navy Activities Descriptions*) of the 2020 GOA DSEIS/OEIS and section ES.2.2 (*Proposed Activities in the Western Maneuver Area*) of the 2022 Supplement to the 2020 GOA DSEIS/OEIS.

The Navy describes and analyzes the effects of its training activities within the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS. In its assessment, the Navy concluded that of the activities to be conducted within the GOA Study Area, sonar use and in-air explosives occurring at or above the water surface were the stressors resulting in impacts on marine mammals that could rise to the level of harassment as defined under the MMPA. (The Navy is not proposing to conduct any activities that use in-water or underwater explosives.) Further, these activities are limited to the TMAA. No activities involving sonar use or explosives would occur in the WMA or the portion of the warning area that extends beyond the TMAA. Therefore, the Navy's rulemaking/LOA application provides the Navy's assessment of potential effects from sonar use and explosives occurring at or above the water surface in terms of the various warfare mission areas they are associated with. Those mission areas include the following:

- surface warfare (in-air detonations at or above the water surface); [1] and
- anti-submarine warfare (sonar and other transducers).

The Navy's activities in Air Warfare, Electronic Warfare, Naval Special Warfare, Strike Warfare, Support Operations, and Other Training Activities do not involve sonar and other transducers, detonations at or near the surface, or any other stressors that could result in harassment, serious injury, or mortality of marine mammals. Therefore, the activities in these warfare areas are not discussed further in this proposed rule, but are analyzed fully in the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS. The specific acoustic sources analyzed in this proposed rule are contained in the 2020 GOA DSEIS/OEIS and are presented in the following sections based on the primary mission areas.

Surface Warfare

The mission of surface warfare (named anti-surface warfare in the 2011 GOA Final Environmental Impact Statement (FEIS)/Overseas Environmental Impact Statement (OEIS) and 2016 GOA Final Supplemental Environmental Impact Statement (FSEIS)/OEIS, but since changed by the Navy to ''Surface Warfare'') is to obtain control of sea space from which naval forces may operate, which entails offensive action against surface targets while also defending against enemy forces. In surface warfare, aircraft use guns, air-launched cruise missiles, or other precision-guided munitions; ships employ naval guns and surface-to-surface missiles; and submarines attack surface ships using anti-ship cruise missiles.

Anti-Submarine Warfare

The mission of anti-submarine warfare is to locate, neutralize, and defeat hostile submarine forces that threaten Navy surface forces. Anti-submarine warfare can involve various assets such as aircraft, ships, and submarines which all search for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack submarine threats.

Anti-submarine warfare training addresses basic skills such as detecting and classifying submarines, as well as evaluating sounds to distinguish between enemy submarines and friendly submarines, ships, and marine life. These integrated anti-submarine warfare training exercises are conducted in coordinated, at-sea training events involving submarines, ships, and aircraft.

Overview of the Major Training Exercise Within the GOA Study Area

The training activities in the GOA Study Area are considered to be a major training exercise (MTE). A MTE, for purposes of this rulemaking, is comprised of several unit-level activities conducted by several units operating together, commanded and controlled by a single Commander, and potentially generating more than 100 hours of active sonar. These exercises typically employ an exercise scenario developed to train and evaluate the exercise participants in tactical and operational tasks. In a MTE, most of the activities being directed and coordinated by the Commander in charge of the exercise are identical in nature to the activities conducted during individual, crew, and smaller unit-level training events. In a MTE, however, these disparate training tasks are conducted in concert, rather than in isolation. At most, only one MTE would occur in the GOA Study Area per year (over a maximum of 21 days).

Description of Stressors

The Navy uses a variety of sensors, platforms, weapons, and other devices, including ones used to ensure the safety of Sailors and Marines, to meet its mission. Training with these systems may introduce sound and energy into the environment. The proposed training activities were evaluated to identify specific components that could act as stressors by having direct or indirect impacts on the environment. This analysis included identification of the spatial variation of the identified stressors. The following subsections describe the acoustic and explosive stressors for marine mammals and their habitat (including prey species) within the GOA Study Area. Each description contains a list of activities that may generate the stressor. Stressor/resource interactions that were determined to have de minimis or no impacts (*e.g.,* vessel noise, aircraft noise, weapons noise, and high-altitude (greater than 10 m above the water surface) explosions) were not carried forward for analysis in the Navy's rulemaking/LOA application. The Navy fully considered the possibility of vessel strike, conducted an analysis, and determined that requesting take of marine mammals by vessel strike was not warranted. Although the Navy did not request take for vessel strike, NMFS also fully analyzed the potential for vessel strike of marine mammals as part of this rulemaking. Therefore, this stressor is discussed in detail below. No Sinking Exercise (SINKEX) events are proposed in the GOA Study Area for this rulemaking, nor is establishment and use of a Portable Undersea Tracking Range (PUTR) proposed. NMFS reviewed the Navy's analysis and conclusions on de minimis and no-impact sources, included in Section 3.8.3 (*Environmental Consequences*) of

[1] Defined herein as being within 10 meters of the ocean surface.

the 2020 GOA DSEIS/OEIS and finds them complete and supportable.

Acoustic Stressors

Acoustic stressors include acoustic signals emitted into the water for a specific purpose, such as sonar, other transducers (devices that convert energy from one form to another—in this case, into sound waves), incidental sources of broadband sound produced as a byproduct of vessel movement, aircraft transits, and use of weapons or other deployed objects. Explosives also produce broadband sound but are characterized separately from other acoustic sources due to their unique hazardous characteristics. Characteristics of each of these sound sources are described in the following sections.

In order to better organize and facilitate the analysis of approximately 300 sources of underwater sound used by the Navy, including sonar and other transducers and explosives, a series of source classifications, or source bins, were developed. The source classification bins do not include the broadband noise produced incidental to vessel movement, aircraft transits, and weapons firing. Noise produced from vessel movement, aircraft transits, and use of weapons or other deployed objects is not carried forward because those activities were found to have de minimis or no impacts, as described above.

The use of source classification bins provides the following benefits:

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

• Improves efficiency of source utilization data collection and reporting requirements anticipated under the MMPA authorizations;

• Ensures a precautionary approach to all impact estimates, as all sources within a given class are modeled as the most impactful source (highest source level, longest duty cycle, or largest net explosive weight) within that bin;

• Allows analyses to be conducted in a more efficient manner, without any compromise of analytical results; and

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

Sonar and Other Transducers

Active sonar and other transducers emit non-impulsive sound waves into the water to detect objects, navigate safely, and communicate. Passive sonars differ from active sound sources in that they do not emit acoustic signals; rather, they only receive acoustic information about the environment, or listen. In this proposed rule, the terms sonar and other transducers will be used to indicate active sound sources unless otherwise specified.

The Navy employs a variety of sonars and other transducers to obtain and transmit information about the undersea environment. Some examples are mid-frequency hull-mounted sonars used to find and track enemy submarines; high-frequency small object detection sonars used to detect mines; high-frequency underwater modems used to transfer data over short ranges; and extremely high-frequency (greater than 200 kilohertz (kHz)) doppler sonars used for navigation, like those used on commercial and private vessels. The characteristics of these sonars and other transducers, such as source level, beam width, directivity, and frequency, depend on the purpose of the source. Higher frequencies can carry more information or provide more information about objects off which they reflect, but attenuate more rapidly. Lower frequencies attenuate less rapidly, so they may detect objects over a longer distance, but with less detail.

Propagation of sound produced underwater is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location will be different than near the source due to the interaction of many factors, including propagation loss; how the sound is reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher-frequency sounds propagate. The effects of these factors are explained in Appendix B (*Acoustic and Explosive Concepts*) of the 2020 GOA DSEIS/OEIS. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the TMAA. As noted above, the Navy does not propose to use sonar and other transducers within the WMA.

The sound sources and platforms typically used in naval activities analyzed in the Navy's rulemaking/LOA application are described in Appendix A (*Navy Activities Descriptions*) of the 2020 GOA DSEIS/OEIS. Sonars and other transducers used to obtain and transmit information underwater during Navy training activities generally fall into several categories of use described below.

Anti-Submarine Warfare

Sonar used during anti-submarine warfare would impart the greatest amount of acoustic energy of any category of sonar and other transducers analyzed in this proposed rule. Types of sonars used to detect potential enemy vessels include hull-mounted, towed, line array, sonobuoy, and helicopter dipping sonars. In addition, acoustic targets and decoys (countermeasures) may be deployed to emulate the sound signatures of vessels or repeat received signals.

Most anti-submarine warfare sonars are mid-frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets with distance over which threats can be identified. However, some sources may use higher or lower frequencies. Duty cycles can vary widely, from rarely used to continuously active. For example, anti-submarine warfare sonars can be wide angle in a search mode or highly directional in a track mode.

Most anti-submarine warfare activities involving submarines or submarine targets would occur in waters greater than 600 feet (ft; 183 m) deep due to safety concerns about running aground at shallower depths.

Navigation and Safety

Similar to commercial and private vessels, Navy vessels employ navigational acoustic devices, including speed logs, Doppler sonars for ship positioning, and fathometers. These may be in use at any time for safe vessel operation. These sources are typically highly directional to obtain specific navigational data.

Communication

Sound sources used to transmit data (such as underwater modems), provide location (pingers), or send a single brief release signal to bottom-mounted devices (acoustic release) may be used throughout the TMAA. These sources typically have low duty cycles and are usually only used when it is desirable to send a detectable acoustic message.

Classification of Sonar and Other Transducers

Sonars and other transducers are grouped into classes that share an attribute, such as frequency range or purpose. As detailed below, classes are further sorted by bins based on the frequency or bandwidth; source level; and, when warranted, the application for which the source would be used. Unless stated otherwise, a reference distance of 1 meter (m) is used for sonar and other transducers.

- Frequency of the non-impulsive acoustic source:
  - ○ Low-frequency sources operate below 1 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; and
  - ○ Very-high-frequency sources operate above 100 kHz but below 200 kHz.
- Sound pressure level:
  - ○ Greater than 160 decibels (dB) referenced to 1 micropascal (re: 1 μPa), but less than 180 dB re: 1 μPa;
  - ○ Equal to 180 dB re: 1 μPa and up to and including 200 dB re: 1 μPa; and
  - ○ Greater than 200 dB re: 1 μPa.
- Application for which the source would be used:
  - ○ Sources with similar functions that have similar characteristics, such as pulse length (duration of each pulse), beam pattern, and duty cycle.

The bins used for classifying active sonars and transducers that are quantitatively analyzed in the TMAA are shown in Table 1. While general parameters or source characteristics are shown in the table, actual source parameters are classified.

TABLE 1—SONAR AND OTHER TRANSDUCERS QUANTITATIVELY ANALYZED IN THE TMAA

For annual training activities					
Source class category	Bin	Description	Units	Annual	7-Year total
Mid-Frequency (MF) Tactical and non-tactical sources that produce signals from 1 to 10 kHz.	MF1	Hull-mounted surface ship sonars (*e.g.,* AN/SQS–53C and AN/SQS–60).	H	271	1,897
	MF3	Hull-mounted submarine sonars (*e.g.,* AN/BQQ–10).	H	25	175
	MF4	Helicopter-deployed dipping sonars (*e.g.,* AN/AQS–22).	H	27	189
	MF5	Active acoustic sonobuoys (*e.g.,* DICASS).	I	126	882
	MF6	Active underwater sound signal devices (*e.g.,* MK 84).	I	14	98
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%.	H	42	294
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%.	H	14	98
High-Frequency (HF) Tactical and non-tactical sources that produce signals greater than 10 kHz but less than 100 kHz.	HF1	Hull-mounted submarine sonars (*e.g.,* AN/BQQ–10).	H	12	84
Anti-Submarine Warfare (ASW) Tactical sources used during ASW training activities.	ASW1	MF systems operating above 200 dB.	H	14	98
	ASW2	MF Multistatic Active Coherent sonobuoy (*e.g.,* AN/SSQ–125).	H	42	294
	ASW3	MF towed active acoustic countermeasure systems (*e.g.,* AN/SLQ–25).	H	273	1,911
	ASW4	MF expendable active acoustic device countermeasures (*e.g.,* MK3).	I	7	49

Notes: H = hours, I = count (*e.g.,* number of individual pings or individual sonobuoys), DICASS = Directional Command Activated Sonobuoy System.

Explosive Stressors

The near-instantaneous rise from ambient to an extremely high peak pressure is what makes an explosive shock wave potentially damaging. Farther from an explosive, the peak pressures decay and the explosive waves propagate as an impulsive, broadband sound. Several parameters influence the effect of an explosive: the weight of the explosive in the warhead, the type of explosive material, the boundaries and characteristics of the propagation medium, and the detonation depth in water. The net explosive weight, which is the explosive power of a charge expressed as the equivalent weight of trinitrotoluene (TNT), accounts for the first two parameters. The effects of these factors are explained in Appendix B (*Acoustic and Explosive Concepts*) of the 2020 GOA DSEIS/OEIS.

Explosive Use

Explosive detonations during training activities are from the use of explosive bombs, and naval gun shells; however, no in-water explosive detonations are included as part of the training activities. For purposes of the analysis in this proposed rule, detonations occurring in air at a height of 33 ft (10 m) or less above the water surface, and detonations occurring directly on the water surface, were modeled to detonate at a depth of 0.3 ft (0.1 m) below the water surface since there is currently no other identified methodology for modeling potential effects to marine mammals that are underwater as a result of detonations occurring in-air at or above the surface of the ocean (within 10 m above the surface). This conservative approach over-estimates the potential underwater impacts due to low-altitude and surface explosives by assuming that all explosive energy is released and remains under the water surface.

Explosive stressors resulting from the detonation of some munitions, such as missiles and gun rounds used in air-air and surface-air scenarios, occur at high altitude. The resulting sound energy from those detonations in air would not impact marine mammals. The explosive energy released by detonations in air has been well studied, and basic methods are available to estimate the explosive energy exposure with distance from the detonation (*e.g.,* U.S. Department of the Navy (1975)). In air, the propagation of impulsive noise from an explosion is highly influenced by atmospheric conditions, including temperature and wind. While basic estimation methods do not consider the unique environmental conditions that may be present on a given day, they do allow for approximation of explosive energy propagation under neutral atmospheric conditions. Explosions that occur during Air Warfare would typically be at a sufficient altitude that a large portion of the sound refracts upward due to cooling temperatures with increased altitude. Based on an understanding of the explosive energy released by detonations in air, detonations occurring in air at altitudes greater than 10 m above the surface of the ocean are not likely to result in acoustic impacts on marine mammals; therefore, these types of explosive activities will not be discussed further in this document. (Note that most of these in-air detonations would occur at altitudes substantially greater than 10 m above the surface of the ocean, as described in further detail in section 3.0.4.2.2 (*Explosions in Air*) of the 2020 GOA DSEIS/OEIS.) Activities such as air-surface bombing or surface-surface gunnery scenarios may involve the use of explosive munitions that detonate upon impact with targets at or above the water surface (within 10 m above the surface). For these activities, acoustic effects modeling was undertaken as described below.

In order to organize and facilitate the analysis of explosives, explosive classification bins were developed. The use of explosive classification bins provides the same benefits as described for acoustic source classification bins in the *Acoustic Stressors* section, above.

The explosive bin types and the number of explosives detonating at or above the water surface in the TMAA are shown in Table 2.

TABLE 2—EXPLOSIVE SOURCES QUANTITATIVELY ANALYZED THAT DETONATE AT OR ABOVE THE WATER SURFACE IN THE TMAA

Explosives (source class and net explosive weight (NEW)) (lb.) *	Number of explosives with the specified activity (annually)	Number of explosives with the specified activity (7-year total)
E5 (>5–10 lb. NEW)	56	392
E9 (>100–250 lb. NEW)	64	448
E10 (>250–500 lb. NEW)	6	42
E12 (>650–1,000 lb. NEW)	2	14

* All of the E5, E9, E10, and E12 explosives would occur in-air, at or above the surface of the water, and would also occur offshore away from the continental shelf and slope beyond the 4,000-meter isobath.

Propagation of explosive pressure waves in water is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity, which affect how the pressure waves are reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher-frequency components of explosive broadband noise can propagate. Appendix B (*Acoustic and Explosive Concepts*) of the 2020 GOA DSEIS/OEIS explains the characteristics of explosive detonations and how the above factors affect the propagation of explosive energy in the water. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the TMAA.

For in-air explosives detonating at or above the water surface, the model estimating acoustic impacts assumes that all acoustic energy from the detonation is underwater with no loss of sound or energy into the air. Important considerations must be factored into the analysis of results with these modeling assumptions, given that the peak pressure and sound from a detonation in air significantly decreases across the air-water interface as it is partially reflected by the water's surface and partially transmitted underwater, as detailed in the following paragraphs.

Detonation of an explosive in air creates a supersonic high pressure shock wave that expands outward from the point of detonation (Kinney and Graham, 1985; Swisdak, 1975). The near-instantaneous rise from ambient to an extremely high peak pressure is what makes the explosive shock wave potentially injurious to an animal experiencing the rapid pressure change (U.S. Department of the Navy, 2017a). As the shock wave-front travels away from the point of detonation, it slows and begins to behave as an acoustic wave-front travelling at the speed of sound. Whereas a shock wave from a detonation in-air has an abrupt peak pressure, that same pressure disturbance when transmitted through the water surface results in an underwater pressure wave that begins and ends more gradually compared with the in-air shock wave, and diminishes with increasing depth and distance from the source (Bolghasi *et al.,* 2017; Chapman and Godin, 2004; Cheng and Edwards, 2003; Moody, 2006; Richardson *et al.,* 1995; Sawyers, 1968; Sohn *et al.,* 2000; Swisdak, 1975; Waters and Glass, 1970; Woods *et al.,* 2015). The propagation of the shock wave in-air and then transitioning underwater is very different from a detonation occurring deep underwater where there is little interaction with the surface. In the case of an underwater detonation occurring just below the surface, a portion of the energy from the detonation would be released into the air (referred to as surface blow off), and at greater depths a pulsating, air-filled cavitation bubble would form, collapse, and reform around the detonation point (Urick, 1983). The Navy's acoustic effects model for analyzing underwater impacts on marine species does not account for the loss of energy due to surface blow-off or cavitation at depth. Both of these phenomena would diminish the magnitude of the acoustic energy received by an animal under real-world conditions (U.S. Department of the Navy, 2018b).

To more completely analyze the results predicted by the Navy's acoustic effects model from detonations occurring in-air above the ocean surface, it is necessary to consider the transfer of energy across the air-water interface. Much of the scientific literature on the transferal of shock wave impulse across the air-water interface has focused on energy from sonic booms created by fast moving aircraft flying at low altitudes above the ocean (Chapman and Godin, 2004; Cheng and Edwards, 2003; Moody, 2006; Sawyers, 1968; Waters and Glass, 1970). The shock wave created by a sonic boom is similar to the propagation of a pressure wave generated by an explosion (although having a significantly slower rise in peak pressure) and investigations of sonic booms are somewhat informative. Waters and Glass (1970) were also investigating sonic booms, but their methodology involved actual in-air detonations. In those experiments, they detonated blasting caps elevated 30 ft (9 m) above the surface in a flooded quarry and measured the resulting pressure at and below the surface to determine the penetration of the shock wave across the air-water interface. Microphones above the water surface recorded the peak pressure in-air, and hydrophones at various shallow depths underwater recorded the unreflected remainder of the pressure wave after transition across the air-water interface. The peak pressure measurements were compared and the results supported the theoretical expectations for the penetration of a pressure wave from air into water, including the predicted exponential decay of energy with distance from the source underwater. In effect, the air-water interface acted as a low-pass filter eliminating the high-frequency components of the shock wave. At incident angles greater than 14 degrees perpendicular to the surface, most of the shock wave from the detonation was reflected off the water surface, which is consistent with results from similar research (Cheng and Edwards, 2003; Moody, 2006; Yagla and Stiegler, 2003). Given that marine mammals spend, on average, up to 90 percent of their time underwater (Costa, 1993; Costa and Block, 2009), and the shock wave from a detonation is only a few milliseconds in duration, marine mammals are unlikely to be exposed in-air when surfaced.

Vessel Strike

NMFS also considered the chance that a vessel utilized in training activities could strike a marine mammal in the GOA Study Area, including both the TMAA and WMA portions of the Study Area. Vessel strikes have the potential to result in incidental take from serious injury and/or mortality. Vessel strikes are not specific to any particular training activity, but rather are a limited, sporadic, and incidental result of Navy vessel movement within a study area. Vessel strikes from commercial, recreational, and military vessels are known to seriously injure and occasionally kill cetaceans (Abramson *et al.,* 2011; Berman-Kowalewski *et al.,* 2010; Calambokidis, 2012; Douglas *et al.,* 2008; Laggner, 2009; Lammers *et al.,* 2003; Van der Hoop *et al.,* 2012; Van der Hoop *et al.,* 2013), although reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (Jensen and Silber, 2003; Laist *et al.,* 2001). Vessel speed, size, and mass are all important factors in determining both the potential likelihood and impacts of a vessel strike to marine mammals (Conn and Silber, 2013; Gende *et al.,* 2011; Silber *et al.,* 2010; Vanderlaan and Taggart, 2007; Wiley *et al.,* 2016). For large vessels, speed and angle of approach can influence the severity of a strike.

Navy vessels transit at speeds that are optimal for fuel conservation and to meet training requirements. Vessels used as part of the proposed specified activities include ships, submarines, unmanned vessels, and boats ranging in size from small, 22 ft (7 m) rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft (333 m). The average speed of large Navy ships ranges between 10 and 15 knots (kn; 19–28 km/hr), and submarines generally operate at speeds in the range of 8 to 13 kn (15 to 24 km/hr), while a few specialized vessels can travel at faster speeds. Small craft (for purposes of this analysis, less than 18 m in length) have much more variable speeds (0 to 50+ kn (0 to 93+ km/hr)), dependent on the activity), but generally range from 10 to 14 kn (19–26 km/hr). From unpublished Navy data, average median speed for large Navy ships in the other Navy ranges from 2011–2015 varied from 5 to 10 kn (9 to 19 km/hr) with variations by ship class and location (*i.e.,* slower speeds close to the coast). Similar patterns would occur in the GOA Study Area. A full description of Navy vessels that are used during training activities can be found in Section 1.2.1 and Section 2.4.2.1 of the 2011 GOA FEIS/OEIS.

While these speeds are representative of most events, some vessels need to temporarily operate outside of these parameters for certain times or during certain activities. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier engaged in flight operations must adjust its speed through the water accordingly. Also, there are other instances, such as launch and recovery of a small rigid hull inflatable boat; vessel boarding, search, and seizure training events; or retrieval of a target when vessels would be dead in the water or moving slowly ahead to maintain steerage.

Large Navy vessels (greater than 18 m in length) within the offshore areas of range complexes operate differently from commercial vessels in ways that may reduce potential whale collisions. Surface ships operated by or for the Navy have multiple personnel assigned to stand watch at all times when a ship or surfaced submarine is moving through the water (underway). A primary duty of personnel standing watch on surface ships is to detect and report all objects and disturbances sighted in the water that may indicate a threat to the vessel and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per vessel safety requirements, personnel standing watch also report any marine mammals sighted in the path of the vessel as a standard collision avoidance procedure. All vessels proceed at a safe speed so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

Detailed Description of Proposed Activities

Proposed Training Activities

The Navy proposes to conduct a single carrier strike group (CSG) exercise which would last for a maximum of 21 consecutive days in a year. The CSG exercise is comprised of several individual training activities. Table 3 lists and describes those individual activities that may result in takes of marine mammals. The events listed would occur intermittently during the 21 days and could be simultaneous and in the same general area within the TMAA or could be independent and spatially separate from other ongoing activities. The table is organized according to primary mission areas and includes the activity name, associated stressor(s), description and duration of the activity, sound source bin, the areas where the activities are conducted in the GOA Study Area, the maximum number of events per year in the 21-day period, and the maximum number of events over 7 years. Not all sound sources are used with each activity. The ''Annual # of Events'' column indicates the maximum number of times that activity could occur during any single year. The ''7-Year # of Events'' is the maximum number of times an activity would occur over the 7-year period of the proposed regulations if the training occurred each year and at the maximum levels requested. The events listed would occur intermittently during the exercise over a maximum of 21 days. The maximum number of activities may not occur in some years, and historically, training has occurred only every other year. However, to conduct a conservative analysis, NMFS analyzed the maximum times these activities could occur over one year and 7 years. The 2020 GOA DSEIS/OEIS includes more detailed activity descriptions. (Note the Navy proposes no low-frequency active sonar (LFAS) use for the activities in this rulemaking.)

TABLE 3—PROPOSED TRAINING ACTIVITIES ANALYZED FOR THE 7-YEAR PERIOD IN THE GOA STUDY AREA

Stressor category	Activity	Description	Source bin	Annual # of events	7-year # of events
		Surface Warfare			
Explosive	Gunnery Exercise, Surface-to-Surface (GUNEX–S–S).	Surface ship crews fire inert small-caliber, inert medium-caliber, or large-caliber explosive rounds at surface targets.	E5	6	42
Explosive	Bombing Exercise (Air-to-Surface) (BOMBEX [A–S]).	Fixed-wing aircraft conduct bombing exercises against stationary floating targets, towed targets, or maneuvering targets.	E9, E10, E12	18	126
		Anti-Submarine Warfare (ASW)			
Acoustic	Tracking Exercise—Helicopter (TRACKEX—Helo).	Helicopter crews search for, track, and detect submarines.	MF4, MF5, MF6	22	154
Acoustic	Tracking Exercise—Maritime Patrol Aircraft (TRACKEX—MPA).	Maritime patrol aircraft crews search for, track, and detect submarines.	MF5, MF6, ASW2	13	91
Acoustic	Tracking Exercise—Ship (TRACKEX—Ship).	Surface ship crews search for, track, and detect submarines.	ASW1, ASW3, MF1, MF11, MF12.	2	14
Acoustic	Tracking Exercise—Submarine (TRACKEX—Sub).	Submarine crews search for, track, and detect submarines.	ASW4, HF1, MF3	2	14

Notes: S–S = Surface to Surface, A–S = Air to Surface.

Standard Operating Procedures

For training to be effective, personnel must be able to safely use their sensors and weapon systems as they are intended to be used in military missions and combat operations and to their optimum capabilities. Standard operating procedures applicable to training have been developed through years of experience, and their primary purpose is to provide for safety (including public health and safety) and mission success. Because standard operating procedures are essential to safety and mission success, the Navy considers them to be part of the proposed specified activities, and has included them in the analysis. In many cases, there are benefits to natural and cultural resources resulting from standard operating procedures. Standard operating procedures that are recognized as having a potential benefit to marine mammals during training activities are noted below and discussed in more detail within the 2020 GOA DSEIS/OEIS.

- Vessel Safety;
- Weapons Firing Procedures;
- Target Deployment and Retrieval Safety; and
- Towed In-Water Device Procedures.

Standard operating procedures (which are implemented regardless of their secondary benefits) are different from mitigation measures (which are designed entirely for the purpose of avoiding or reducing impacts). Information on mitigation measures is provided in the Proposed Mitigation Measures section below. Additional information on standard operating procedures is presented in Section 2.3.2 (Standard Operating Procedures) in the 2020 GOA DSEIS/OEIS.

Description of Marine Mammals and Their Habitat in the Area of the Specified Activities

Marine mammal species and their associated stocks that have the potential to occur in the GOA Study Area are presented in Table 4 along with each stock's ESA and MMPA statuses, abundance estimate and associated coefficient of variation value, minimum abundance estimate, and expected occurrence in the GOA Study Area. The Navy requested authorization to take individuals of 16 marine mammal species by Level A harassment and Level B harassment, and NMFS has conservatively analyzed and proposes to authorize incidental take of two additional species. The Navy does not request authorization for any serious injuries or mortalities of marine mammals, and NMFS agrees that serious injury and mortality is unlikely to occur from the Navy's activities. NMFS recently designated critical habitat under the Endangered Species Act (ESA) for humpback whales in the TMAA portion of the GOA Study Area, and this designated critical habitat is considered below (86 FR 21082; April 21, 2021). The WMA portion of the GOA Study Area does not overlap ESA-designated critical habitat for humpback whales or any other species.

Information on the status, distribution, abundance, population trends, habitat, and ecology of marine mammals in the GOA Study Area may be found in Chapter 4 of the Navy's rulemaking/LOA application. NMFS has reviewed this information and found it to be accurate and complete. Additional information on the general biology and ecology of marine mammals is included in the 2020 GOA DSEIS/OEIS. Table 4 incorporates the best available science, including data from the 2020 U.S. Pacific and the Alaska Marine Mammal Stock Assessment Reports (SARs; Carretta *et al.,* 2021; Muto *et al.,* 2021), 2021 draft U.S. Pacific and Alaska Marine Mammal SARs, as well as monitoring data from the Navy's marine mammal research efforts.

To better define marine mammal occurrence in the TMAA, the portion of the GOA Study Area where take of marine mammals is anticipated to occur, four regions within the TMAA were defined (and are depicted in Figure 3–1 of the Navy's rulemaking/LOA application), consistent with the survey strata used by Rone *et al.* (2017) during the most recent marine mammal surveys in the TMAA. The four regions are: inshore, slope, seamount, and offshore.

Species Not Included in the Analysis

There has been no change in the species unlikely to be present in the GOA Study Area since the last MMPA rulemaking process (82 FR 19530; April 27, 2017). The species carried forward for analysis are those likely to be found in the GOA Study Area based on the most recent data available and do not include species that may have once inhabited or transited the area but have not been sighted in recent years (*e.g.,* species which were extirpated from factors such as 19th and 20th century commercial exploitation). Several species and stocks that may be present in the northeast Pacific Ocean generally have an extremely low probability of presence in the GOA Study Area. These species and stocks are considered extralimital (may be sightings, acoustic detections, or stranding records, but the GOA Study Area is outside the species' range of normal occurrence) or rare (occur in the GOA Study Area sporadically, but sightings are rare). These species and stocks include the Eastern North Pacific Northern Resident and the West Coast Transient stocks of killer whale (*Orcinus orca*), 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*).

The Eastern North Pacific Northern Resident and the West Coast Transient stocks of killer whale are considered extralimital in the GOA Study Area. Given the paucity of any beluga whale sightings in the GOA (Laidre *et al.* 2000), the occurrence of this species within the GOA Study Area is considered extralimital. The GOA Study Area is also outside of the normal range of the false killer whale's distribution in the Pacific Ocean, and despite rare stranding or sighting reports, the GOA Study Area is outside of the normal range of the short-finned pilot whale as well. There are two sighting records of northern right whale dolphins in the Gulf of Alaska, but these are considered extremely rare (U.S. Department of the Navy 2006; NOAA 2012) and extralimital in the GOA Study Area. There are a few records of Risso's dolphins near the GOA Study Area; however, their occurrence within the GOA Study Area is rare, and therefore Risso's dolphin is considered extralimital. NMFS agrees with the Navy's assessment that these species are unlikely to occur in the GOA Study Area and they are not discussed further.

One species of marine mammal, the Northern sea otter, occurs in the Gulf of Alaska but is managed by the U.S. Fish and Wildlife Service and is not considered further in this document.

TABLE 4—MARINE MAMMAL OCCURRENCE WITHIN THE GOA STUDY AREA

Common name	Scientific name	Stock	ESA status, MMPA status, strategic (Y/N) [1]	Stock abundance (CV, Nmin, year of most recent abundance survey) [2]	PBR	Annual M/SI [3]	Occurrence in GOA study area [4]
Order Cetacea—Suborder Mysticeti (baleen whales)							
Family Balaenidae (right whales):							
North Pacific right whale.	*Eubalaena japonica*	Eastern North Pacific	E, D, Y	31 (0.226, 26, 2008)	[5] 0.05	0	Rare.
Family Balaenopteridae (rorquals):							
Humpback whale	*Megaptera novaeangliae.*	Central North Pacific [6]	-, -, Y	10,103 (0.3, 7,891, 2006).	83	26	Seasonal; highest likelihood June to September.
		California, Oregon, and Washington [6].	-, -, Y	4,973 (0.05, 4,776, 2018).	28.7	≥48.6	Seasonal; highest likelihood June to September.
		Western North Pacific	E, D, Y	1,107 (0.3, 865, 2006)	3	2.8	Seasonal; highest likelihood June to September.
Blue whale	*Balaenoptera musculus*	Eastern North Pacific	E, D, Y	1,898 (0.085, 1,767, 2018).	4.1	≥19.4	Seasonal; highest likelihood June to December.
		Central North Pacific	E, D, Y	133 (1.09, 63, 2010)	0.1	0	Seasonal; highest likelihood June to December.
Fin whale	*Balaenoptera physalus*	Northeast Pacific	E, D, Y	3,168 (0.26, 2,554, 2013) [7].	5.1	0.6	Likely.
Sei whale	*Balaenoptera borealis*	Eastern North Pacific [8]	E, D, Y	519 (0.4, 374, 2014)	0.75	≥0.2	Rare.
Minke whale	*Balaenoptera acutorostrata.*	Alaska	-, -, N	UNK	UND	0	Likely.
Family Eschrichtiidae (gray whale):							
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	-, -, N	26,960 (0.05, 25,849, 2016).	801	131	Likely: Highest numbers during seasonal migrations (fall, winter, spring).

TABLE 4—MARINE MAMMAL OCCURRENCE WITHIN THE GOA STUDY AREA—Continued

Common name	Scientific name	Stock	ESA status, MMPA status, strategic (Y/N) [1]	Stock abundance (CV, Nmin, year of most recent abundance survey) [2]	PBR	Annual M/SI [3]	Occurrence in GOA study area [4]
		Western North Pacific	E, D, Y	290 (N/A, 271, 2016)	0.12	UNK	Rare: Individuals migrate through GOA.
Order Cetacea—Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale):							
Sperm whale	*Physeter macrocephalus*.	North Pacific	E, D, Y	345 (0.43, 244, 2015) [9]	UND	3.5	Likely; More likely in waters >1,000 m depth, most often >2,000 m.
Family Delphinidae (dolphins):							
Killer whale	Orcinus orca	Eastern North Pacific Alaska Resident.	-, -, N	[10] 2,347 (N/A, 2,347, 2012).	24	1	Likely.
		Eastern North Pacific Offshore.	-, -, N	300 (0.1, 276, 2012)	2.8	0	Likely.
		AT1 Transient	-, D, Y	[10] 7 (N/A, 7, 2018)	0.01	0	Rare; more likely inside Prince William Sound and Kenai Fjords.
		Eastern North Pacific GOA, Aleutian Island, and Bering Sea Transient.	-, -, N	[10] 587 (N/A, 587, 2012)	5.87	0.8	Likely.
Pacific white-sided dolphin.	*Lagenorhynchus obliquidens*.	North Pacific	-, -, N	26,880 (N/A, N/A, 1990).	UND	0	Likely.
Family Phocoenidae (porpoises):							
Harbor porpoise	*Phocoena phocoena*	GOA	-, -, Y	31,046 (0.21, N/A, 1998).	UND	72	Rare; Inshore and Slope Regions, if present.
		Southeast Alaska	-, -, Y	1,354 (0.12, 1,224, 2012).	12	34	Rare.
Dall's porpoise	*Phocoenoides dalli*	Alaska	-, -, N	83,400 (0.097, 3,110, 2015).	UND	37	Likely.
Family Ziphiidae (beaked whales):							
Cuvier's beaked whale.	*Ziphius cavirostris*	Alaska	-, -, N	UNK	UND	0	Likely.
Baird's beaked whale.	*Berardius bairdii*	Alaska	-, -, N	UNK	UND	0	Likely.
Stejneger's beaked whale.	*Mesoplodon stejnegeri*	Alaska	-, -, N	UNK	UND	0	Likely.
Order Carnivora—Suborder Pinnipedia [8]							
Family Otarieidae (fur seals and sea lions):							
Steller sea lion	*Eumetopias jubatus*	Eastern U.S	-, -, N	[11] 43,201 (N/A, 43,201, 2017).	2,592	112	Rare.
		Western U.S.	E, D, Y	[11] 52,932 (N/A, 52,932, 2013).	318	254	Likely; Inshore region.
California sea lion	*Zalophus californianus*	U.S	-, -, N	257,606 (N/A, 233,515, 2014).	14,011	>320	Rare (highest likelihood April and May).
Northern fur seal	*Callorhinus ursinus*	Eastern Pacific	-, D, Y	626,618 (0.2, 530,376, 2019).	11,403	373	Likely.
		California	-, D, N	14,050 (N/A, 7,524, 2013).	451	1.8	Rare.
Family Phocidae (true seals):							
Northern elephant seal.	*Mirounga angustirostris*	California Breeding	-, -, N	187,386 (N/A, 85,369, 2013).	5,122	5.3	Seasonal (highest likelihood July–September).
Harbor seal	*Phoca vitulina*	N Kodiak	-, -, N	8,677 (N/A, 7,609, 2017).	228	38	Likely; Inshore region.
		S Kodiak	-, -, N	26,448 (N/A, 22,351, 2017).	939	127	Likely; Inshore region.
		Prince William Sound	-, -, N	44,756 (N/A, 41,776, 2015).	1,253	413	Likely; Inshore region.
		Cook Inlet/Shelikof	-, -, N	28,411 (N/A, 26,907, 2018).	807	107	Likely; Inshore region.
Ribbon seal	*Histriophoca fasciata*	Unidentified	-, -, N	184,697 (N/A, 163,086, 2013).	9,785	163	Rare.

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, M/SI = mortality and serious injury, UNK = unknown, UND = undetermined.

[1] Endangered Species Act (ESA) status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds potential biological removal (PBR) or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[2] The stocks and stock abundance number are as provided in Carretta *et al.,* 2021 and Muto *et al.,* 2021. Nmin is the minimum estimate of stock abundance. In some cases, CV is not applicable. NMFS marine mammal stock assessment reports online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region.*

[3] These values, found in NMFS' SARs, represent annual levels of human-caused mortality and serious injury (M/SI) from all sources combined (*e.g.,* commercial fisheries, ship strike). Annual mortality and serious injury (M/SI) often cannot be determined precisely and is in some cases presented as a minimum value or range. A CV associated with estimated mortality due to commercial fisheries is presented in some cases.

[4] RARE: The distribution of the species is near enough to the GOA Study Area that the species could occur there, or there are a few confirmed sightings. LIKELY: Year-round sightings or acoustic detections of the species in the GOA Study Area, although there may be variation in local abundance over the year. SEASONAL: Species absence and presence as documented by surveys or acoustic monitoring. Regions within the GOA Study Area follow those presented in Rone *et al.* (2015); Rone *et al.* (2009); Rone *et al.* (2014); Rone *et al.* (2017): inshore, slope, seamount, and offshore.

[5] See SAR for more details

[6] Humpback whales in the Central North Pacific stock and the California, Oregon, and Washington stock are from three Distinct Population Segments based on animals identified in breeding areas in Hawaii, Mexico, and Central America (Carretta *et al.,* 2021; Muto *et al.,* 2021; National Marine Fisheries Service, 2016c).

[7] The SAR reports this stock abundance assessment as provisional and notes that it is an underestimate for the entire stock because it is based on surveys which covered only a small portion of the stock's range.

[8] This analysis assumes that these individuals are from the Eastern North Pacific stock; however, they are not discussed in the West Coast or the Alaska Stock Assessment Reports (Carretta *et al.,* 2021; Muto *et al.,* 2021).

[9] The SAR reports that this is an underestimate for the entire stock because it is based on surveys of a small portion of the stock's extensive range and it does not account for animals missed on the trackline or for females and juveniles in tropical and subtropical waters.

[10] Stock abundance is based on counts of individual animals identified from photo-identification catalogues. Surveys for abundance estimates of these stocks are conducted infrequently.

[11] Stock abundance is the best estimate of pup and non-pup counts, which have not been corrected to account for animals at sea during abundance surveys.

Below, we consider additional information about the marine mammals in the area of the specified activities that informs our analysis, such as identifying known areas of important habitat or behaviors, or where Unusual Mortality Events (UME) have been designated.

Critical Habitat

On April 21, 2021 (86 FR 21082), NMFS published a final rule designating critical habitat for the endangered Western North Pacific DPS, the endangered Central America DPS, and the threatened Mexico DPS of humpback whales, including specific marine areas located off the coasts of California, Oregon, Washington, and Alaska. Based on consideration of national security, economic impacts, and data deficiency in some areas, NMFS excluded certain areas from the designation for each DPS.

NMFS identified prey species, primarily euphausiids and small pelagic schooling fishes (see the final rule for particular prey species identified for each DPS; 86 FR 21082; April 21, 2021) of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth, as an essential habitat feature. NMFS, through a critical habitat review team (CHRT), also considered inclusion of migratory corridors and passage features, as well as sound and the soundscape, as essential habitat features. However, NMFS did not include either, as the CHRT concluded that the best available science did not allow for identification of any consistently used migratory corridors or definition of any physical, essential migratory or passage conditions for whales transiting between or within habitats of the three DPSs. The best available science also currently does not enable NMFS to identify a sound-related habitat feature that is essential to the conservation of humpback whales.

NMFS considered the co-occurrence of this designated humpback whale critical habitat and the GOA Study Area. Figure 4–1 of the Navy's rulemaking/LOA application shows the overlap of the humpback whale critical habitat with the TMAA. As shown in the Navy's rulemaking/LOA application, the TMAA overlaps with humpback whale critical habitat Unit 5 (destination for whales from the Hawaii, Mexico, and Western North Pacific DPSs; Calambokidis *et al.,* 2008) and Unit 8 (destination for whales from the Hawaii and Mexico DPSs (Baker *et al.,* 1986, Calambokidis *et al.,* 2008); Western North Pacific DPS whales have not been photo-identified in this specific area, but presence has been inferred based on available data indicating that humpback whales from Western North Pacific wintering areas occur in the Gulf of Alaska (NMFS 2020, Table C5)). Approximately 4 percent of the humpback whale critical habitat in the GOA region overlaps with the TMAA, and approximately 2 percent of critical habitat in both the GOA and U.S. west coast regions combined overlaps with the TMAA. The WMA portion of the GOA Study Area does not overlap ESA-designated critical habitat for humpback whales.

As noted above in the *Geographical Region* section, the TMAA boundary was intentionally designed to avoid ESA-designated Western DPS (MMPA Western U.S. stock) Steller sea lion critical habitat.

Biologically Important Areas

BIAs include areas of known importance for reproduction, feeding, or migration, or areas where small and resident populations are known to occur (Van Parijs, 2015). Unlike ESA critical habitat, these areas are not formally designated pursuant to any statute or law, but are a compilation of the best available science intended to inform impact and mitigation analyses. An interactive map of BIAs may be found here: *https://cetsound.noaa.gov/biologically-important-area-map.*

The WMA does not overlap with any known BIAs. BIAs in the GOA that overlap portions of the TMAA include the following feeding and migration areas: North Pacific right whale feeding BIA (June–September); Gray whale migratory corridor BIA (November–January, southbound; March–May, northbound) (Ferguson *et al.,* 2015). Fin whale feeding areas (east, west, and southwest of Kodiak Island) occur to the west of the TMAA and gray whale feeding areas occur both east (Southeast Alaska) and west (Kodiak Island) of the TMAA; however, these feeding areas are located well outside of (≤ 20 nmi (37 km)) the TMAA and beyond the Navy's estimated range to effects for take by Level A harassment and Level B harassment.

A portion of the North Pacific right whale feeding BIA overlaps with the western side of the TMAA by approximately 2,051 square kilometers (km^2; approximately 1.4 percent of the TMAA, and 7 percent of the feeding BIA). A small portion of the gray whale migration corridor BIA also overlaps with the western side of the TMAA by approximately 1,582 km^2 (approximately 1 percent of the TMAA, and 1 percent of the migration corridor BIA). To mitigate impacts to marine mammals in these BIAs, the Navy would implement several procedural mitigation measures and mitigation areas (described in the Proposed Mitigation Measures section).

Unusual Mortality Events (UMEs)

A UME is defined under Section 410(6) of the MMPA as a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response. There is one UME that is applicable to our evaluation of the Navy's activities in the GOA Study Area. The gray whale UME along the west coast of North America is active and involves ongoing investigations in the GOA that inform our analysis are discussed below.

Gray Whale UME

Since January 1, 2019, elevated gray whale strandings have occurred along the west coast of North America, from Mexico to Canada. As of June 3, 2022, there have been a total of 578 strandings along the coasts of the United States, Canada, and Mexico, with 278 of those strandings occurring along the U.S. coast. Of the strandings on the U.S. coast, 118 have occurred in Alaska, 66 in Washington, 14 in Oregon, and 80 in California. Full or partial necropsy examinations were conducted on a subset of the whales. Preliminary findings in several of the whales have shown evidence of emaciation. These findings are not consistent across all of the whales examined, so more research is needed. As part of the UME investigation process, NOAA has assembled an independent team of scientists to coordinate with the Working Group on Marine Mammal Unusual Mortality Events to review the data collected, sample stranded whales, consider possible causal-linkages between the mortality event and recent ocean and ecosystem perturbations, and determine the next steps for the investigation. Please refer to: *https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2022-gray-whale-unusual-mortality-event-along-west-coast-and* for more information on this UME.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): generalized hearing is estimated to occur between approximately 7 Hz and 35 kHz;
- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High-frequency cetaceans (porpoises, river dolphins, and members of the genera Kogia and Cephalorhynchus; including two members of the genus Lagenorhynchus, on the basis of recent echolocation data and genetic data): generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz;
- Pinnipeds in water; Phocidae (true seals): generalized hearing is estimated to occur between approximately 50 Hz to 86 kHz; and
- Pinnipeds in water; Otariidae (eared seals): generalized hearing is estimated to occur between 60 Hz and 39 kHz.

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.,* 2006; Kastelein *et al.,* 2009; Reichmuth and Holt, 2013).

For more details concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of the available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section includes a discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The Estimated Take of Marine Mammals section later in this rule includes a quantitative analysis of the number of instances of take that could occur from these activities. The Preliminary Analysis and Negligible Impact Determination section considers the content of this section, the Estimated Take of Marine Mammals section, and the Proposed Mitigation Measures section to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and whether those impacts on individuals are likely to adversely affect the species through effects on annual rates of recruitment or survival.

The Navy has requested authorization for the take of marine mammals that may occur incidental to training activities in the GOA Study Area. The Navy analyzed potential impacts to marine mammals in its rulemaking/LOA application. NMFS carefully reviewed the information provided by the Navy along with independently reviewing applicable scientific research and literature and other information to evaluate the potential effects of the Navy's activities on marine mammals, which are presented in this section. (As noted above, activities that would result in take of marine mammals would only occur in the TMAA portion of the GOA Study Area.)

Other potential impacts to marine mammals from training activities in the GOA Study Area were analyzed in the Navy's rulemaking/LOA application as well as in the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS, in consultation with NMFS as a cooperating agency, and determined to be unlikely to result in marine mammal take. These include incidental take from vessel strike and serious injury or mortality from explosives. Therefore, the Navy did not request authorization for incidental take of marine mammals by vessel strike or serious injury or mortality from explosives from its proposed specified activities. NMFS has carefully considered the information in the 2020 GOA DSEIS/OEIS, the 2022 Supplement to the 2020 GOA DSEIS/OEIS, and all other pertinent information and agrees that incidental take is unlikely to occur from these sources. NMFS conducted a detailed analysis of the potential for vessel strike, and based on that analysis, NMFS does not anticipate vessel strikes of large whales or smaller marine mammals in the GOA Study Area. In this proposed rule, NMFS analyzes the potential effects of the Navy's activities on marine mammals in the GOA Study Area, focusing primarily on the activity components that may cause the take of marine mammals: exposure to acoustic or explosive stressors including non-impulsive (sonar and other transducers) and impulsive (explosives) stressors.

For the purpose of MMPA incidental take authorizations, NMFS' effects assessments serve four primary purposes: (1) to determine whether the specified activities would have a negligible impact on the affected species or stocks of marine mammals (based on whether it is likely that the activities would adversely affect the species or stocks through effects on annual rates of recruitment or survival); (2) to determine whether the specified activities would have an unmitigable adverse impact on the availability of the species or stocks for subsistence uses; (3) to prescribe the permissible methods of taking (*i.e.,* Level B harassment (behavioral disturbance and temporary threshold shift (TTS)), Level A harassment (permanent threshold shift (PTS) and non-auditory injury), serious injury, or mortality), including identification of the number and types of take that could occur by harassment, serious injury, or mortality, and to prescribe means of effecting the least practicable adverse impact on the species or stocks and their habitat (*i.e.,* mitigation measures); and (4) to prescribe requirements pertaining to monitoring and reporting.

In this section, NMFS provides a description of the ways marine mammals potentially could be affected by these activities in the form of mortality, physical trauma, sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particularly stress responses), behavioral disturbance, or habitat effects. The Estimated Take of Marine Mammals section discusses how the potential effects on marine mammals from non-impulsive and impulsive sources relate to the MMPA definitions of Level A Harassment and Level B Harassment, and quantifies those effects that rise to the level of a take. The Preliminary Analysis and Negligible Impact Determination section assesses whether the proposed authorized take would have a negligible impact on the affected species and stocks.

Potential Effects of Underwater Sound

Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can possibly result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral response, stress, and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009, Southall *et al.,* 2019a). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing can occur after exposure to noise, and occurs almost exclusively for noise within an animal's hearing range. Note that in the following discussion, we refer in many cases to a review article concerning studies of noise-induced hearing loss conducted from 1996–2015 (*i.e.,* Finneran, 2015). For study-specific citations, please see that work. We first describe general manifestations of acoustic effects before providing discussion specific to the Navy's activities.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We also describe more severe potential effects (*i.e.,* certain non-auditory physical or physiological effects). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015).

Acoustic Sources

Direct Physiological Effects

Non-impulsive sources of sound can cause direct physiological effects including noise-induced loss of hearing sensitivity (or ''threshold shift''), nitrogen decompression, acoustically-induced bubble growth, and injury due to sound-induced acoustic resonance. Only noise-induced hearing loss is anticipated to occur due to the Navy's activities. Acoustically-induced (or mediated) bubble growth and other pressure-related physiological impacts are addressed below, but are not expected to result from the Navy's activities. 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 and Mortality* subsection.

Hearing Loss—Threshold Shift

Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift, which is the loss of hearing sensitivity at certain frequency ranges after cessation of sound (Finneran, 2015). Threshold shift can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). TTS can last from minutes or hours to days (*i.e.,* there is recovery back to baseline/pre-exposure levels), can occur within a specific frequency range (*i.e.,* an animal might only have a temporary loss of hearing sensitivity within a limited frequency band of its auditory range), and can be of varying amounts (*e.g.,* an animal's hearing sensitivity might be reduced by only 6 dB or reduced by 30 dB). While there is no simple functional relationship between TTS and PTS or other auditory injury (*e.g.,* neural degeneration), as TTS increases, the likelihood that additional exposure sound pressure level (SPL) or duration will result in PTS or other injury also increases (see also the 2020 GOA DSEIS/OEIS for additional discussion). Exposure thresholds for the onset of PTS or other auditory injury are defined by the amount of sound energy that results in 40 dB of TTS. This value is informed by experimental data, and is used as a proxy for the onset of auditory injury; *i.e.,* it is assumed that exposures beyond those capable of causing 40 dB of TTS have the potential to result in PTS or other auditory injury (*e.g.,* loss of cochlear neuron synapses, even in the absence of PTS). In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.,* tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.,* 2007). PTS is permanent (*i.e.,* there is incomplete recovery back to baseline/pre-exposure levels), but also can occur in a specific frequency range and amount as mentioned above for TTS. In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

The following physiological mechanisms are thought to play a role in inducing auditory threshold shift: 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 threshold shift and the frequency range in which it occurs. Generally, the amount of threshold shift, and the time needed to recover from the effect, increase as amplitude and duration of sound exposure increases. Human non-impulsive noise exposure guidelines are based on the assumption that exposures of equal energy (the same sound exposure level (SEL)) produce equal amounts of hearing impairment regardless of how the sound energy is distributed in time (NIOSH, 1998). Previous marine mammal TTS studies have also generally supported this equal energy relationship (Southall *et al.,* 2007). However, some more recent studies concluded that for all noise exposure situations the equal energy relationship may not be the best indicator to predict TTS onset levels (Mooney *et al.,* 2009a and 2009b; Kastak *et al.,* 2007). These studies highlight the inherent complexity of predicting TTS onset in marine mammals, as well as the importance of considering exposure duration when assessing potential impacts. Generally, with sound exposures of equal energy, those that were quieter (lower SPL) with longer duration were found to induce TTS onset at lower levels than those of louder (higher SPL) and shorter duration. Less threshold shift will occur from intermittent sounds than from a continuous exposure with the same energy (some recovery can occur between intermittent exposures) (Kryter *et al.,* 1966; Ward, 1997; Mooney *et al.,* 2009a, 2009b; Finneran *et al.,* 2010). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer (lower SPL) sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, very prolonged or repeated exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold can cause PTS, at least in terrestrial mammals (Kryter, 1985; Lonsbury-Martin *et al.,* 1987).

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).

The NMFS Acoustic Technical Guidance (NMFS, 2018), which was used in the assessment of effects for this rule, compiled, interpreted, and synthesized the best available scientific information for noise-induced hearing effects for marine mammals to derive updated thresholds for assessing the impacts of noise on marine mammal hearing. More recently, Southall *et al.* (2019a) evaluated Southall *et al.* (2007) and used updated scientific information to propose revised noise exposure criteria to predict onset of auditory effects in marine mammals (*i.e.,* PTS and TTS onset). Southall *et al.* (2019a) note that the quantitative processes described and the resulting exposure criteria (*i.e.,* thresholds and auditory weighting functions) are largely identical to those in Finneran (2016) and NMFS (2018). They only differ in that the Southall *et al.* (2019a) exposure criteria are more broadly applicable as they include all marine mammal species (rather than only those under NMFS jurisdiction) for all noise exposures (both in air and underwater for amphibious species) and, while the hearing group compositions are identical, they renamed the hearing groups. Southall *et al.* (2021) updated the behavioral response severity criteria laid out in Southall *et al.* (2007) and included recommendations on how to present and score behavioral responses in future work.

Many studies have examined noise-induced hearing loss in marine mammals (see Finneran (2015) and Southall *et al.* (2019a) for summaries), however for cetaceans, published data on the onset of TTS are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise, and for pinnipeds in water, measurements of TTS are limited to harbor seals, elephant seals, and California sea lions. These studies examine hearing thresholds measured in marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds can then be used to determine the amount of threshold shift at various post-exposure times. NMFS has reviewed the available studies, which are summarized below (see also the 2020 GOA DSEIS/OEIS which includes additional discussion on TTS studies related to sonar and other transducers).

- The method used to test hearing may affect the resulting amount of measured TTS, with neurophysiological measures producing larger amounts of TTS compared to psychophysical measures (Finneran *et al.,* 2007; Finneran, 2015).
- The amount of TTS varies with the hearing test frequency. As the exposure SPL increases, the frequency at which the maximum TTS occurs also increases (Kastelein *et al.,* 2014b). For high-level exposures, the maximum TTS typically occurs one-half to one octave above the exposure frequency (Finneran *et al.,* 2007; Mooney *et al.,* 2009a; Nachtigall *et al.,* 2004; Popov *et al.,* 2011; Popov *et al.,* 2013; Schlundt *et al.,* 2000;

Kastelein *et al.,* 2021b; Kastelien *et al.,* 2022). The overall spread of TTS from tonal exposures can therefore extend over a large frequency range (*i.e.,* narrowband exposures can produce broadband (greater than one octave) TTS).

• The amount of TTS increases with exposure SPL and duration and is correlated with SEL, especially if the range of exposure durations is relatively small (Kastak *et al.,* 2007; Kastelein *et al.,* 2014b; Popov *et al.,* 2014). As the exposure duration increases, however, the relationship between TTS and SEL begins to break down. Specifically, duration has a more significant effect on TTS than would be predicted on the basis of SEL alone (Finneran *et al.,* 2010a; Kastak *et al.,* 2005; Mooney *et al.,* 2009a). This means if two exposures have the same SEL but different durations, the exposure with the longer duration (thus lower SPL) will tend to produce more TTS than the exposure with the higher SPL and shorter duration. In most acoustic impact assessments, the scenarios of interest involve shorter duration exposures than the marine mammal experimental data from which impact thresholds are derived; therefore, use of SEL tends to over-estimate the amount of TTS. Despite this, SEL continues to be used in many situations because it is relatively simple, more accurate than SPL alone, and lends itself easily to scenarios involving multiple exposures with different SPL.

• Gradual increases of TTS may not be directly observable with increasing exposure levels, before the onset of PTS (Reichmuth *et al.,* 2019). Similarly, PTS can occur without measurable behavioral modifications (Reichmuth *et al.,* 2019).

• The amount of TTS depends on the exposure frequency. Sounds at low frequencies, well below the region of best sensitivity, are less hazardous than those at higher frequencies, near the region of best sensitivity (Finneran and Schlundt, 2013). The onset of TTS—defined as the exposure level necessary to produce 6 dB of TTS (*i.e.,* clearly above the typical variation in threshold measurements)—also varies with exposure frequency. At low frequencies, onset-TTS exposure levels are higher compared to those in the region of best sensitivity. For example, for harbor porpoises exposed to one-sixth octave noise bands at 16 kHz (Kastelein *et al.,* 2019f), 32 kHz (Kastelein *et al.,* 2019d), 63 kHz (Kastelein *et al.,* 2020a), and 88.4 kHz (Kastelein *et al.,* 2020b), less susceptibility to TTS was found as frequency increased, whereas exposure frequencies below ~6.5 kHz showed an increase in TTS susceptibility as frequency increased and approached the region of best sensitivity. Kastelein *et al.* (2020b) showed a much higher onset of TTS for a 88.5 kHz exposure as compared to lower exposure frequencies (*i.e.,* 16 kHz (Kastelein *et al.,* 2019) 1.5 kHz and 6.5 kHz (Kastelein *et al.,* 2020a)). For the 88.4 kHz test frequency, a 185 dB re 1 micropascal squared per second (μPa^2-s) exposure resulted in 3.6 dB of TTS, and a 191 dB re 1 μPa^2-s exposure produced 5.2 dB of TTS at 100 kHz and 5.4 dB of TTS at 125 kHz. Together, these new studies demonstrate that the criteria for high-frequency (HF) cetacean auditory impacts is likely to be conservative.

• TTS can accumulate across multiple exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same SEL (Finneran *et al.,* 2010a; Kastelein *et al.,* 2014b; Kastelein *et al.,* 2015b; Mooney *et al.,* 2009b). This means that TTS predictions based on the total, cumulative SEL will overestimate the amount of TTS from intermittent exposures such as sonars and impulsive sources. The importance of duty cycle in predicting the likelihood of TTS is demonstrated further in Kastelein *et al.* (2021b). The authors found that reducing the duty cycle of a sound generally reduced the potential for TTS in California sea lions, and that, further, California sea lions are more susceptible to TTS than previously believed at the 2 and 4 kHz frequencies tested.

• The amount of observed TTS tends to decrease with increasing time following the exposure; however, the relationship is not monotonic (*i.e.,* increasing exposure does not always increase TTS). The time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts recovery may be complete in a few minutes, while large shifts (*e.g.,* approximately 40 dB) may require several days for recovery. Recovery times are consistent for similar-magnitude TTS, regardless of the type of fatiguing sound exposure (impulsive, continuous noise band, or sinusoidal wave; (Kastelein *et al.,* 2019e)). Under many circumstances TTS recovers linearly with the logarithm of time (Finneran *et al.,* 2010a, 2010b; Finneran and Schlundt, 2013; Kastelein *et al.,* 2012a; Kastelein *et al.,* 2012b; Kastelein *et al.,* 2013a; Kastelein *et al.,* 2014b; Kastelein *et al.,* 2014c; Popov *et al.,* 2011; Popov *et al.,* 2013; Popov *et al.,* 2014). This means that for each doubling of recovery time, the amount of TTS will decrease by the same amount (*e.g.,* 6 dB recovery per doubling of time). Please see Section 3.8.3.1.1.2 of the 2020 GOA DSEIS/OEIS for discussion of additional threshold shift literature.

Nachtigall *et al.* (2018) and Finneran (2018) describe the measurements of hearing sensitivity of multiple odontocete species (bottlenose dolphin, harbor porpoise, beluga, and false killer whale) when a relatively loud sound was preceded by a warning sound. These captive animals were shown to reduce hearing sensitivity when warned of an impending intense sound. Based on these experimental observations of captive animals, the authors suggest that wild animals may dampen their hearing during prolonged exposures or if conditioned to anticipate intense sounds. Another study showed that echolocating animals (including odontocetes) might have anatomical specializations that might allow for conditioned hearing reduction and filtering of low-frequency ambient noise, including increased stiffness and control of middle ear structures and placement of inner ear structures (Ketten *et al.,* 2021). Finneran recommends further investigation of the mechanisms of hearing sensitivity reduction in order to understand the implications for interpretation of existing TTS data obtained from captive animals, notably for considering TTS due to short duration, unpredictable exposures.

Marine mammal hearing plays a critical role in communication with conspecifics and in interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.,* recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious, similar to those discussed in auditory masking below. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that takes place during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that impeded communication. Animals exposed to high levels of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature, which is potentially more significant than simple existence of a TTS. However, it is important to note that TTS could occur due to longer exposures to sound at lower levels so that a behavioral response may not be elicited.

Depending on the degree and frequency range, the effects of PTS on an animal could also range in severity, although it is considered generally more serious than TTS because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.,* 2007), so we can infer that strategies exist for coping with this condition to some degree, though likely not without some cost to the animal.

Acoustically-Induced Bubble Formation Due to Sonars and Other Pressure-Related Impacts

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 (in combination with the source levels) 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 because 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; Cox *et al.,* 2006; Rommel *et al.,* 2006). Crum and Mao (1996) hypothesized that received levels would have to exceed 190 dB in order for there to be the possibility of significant bubble growth due to supersaturation of gases in the blood (*i.e.,* rectified diffusion). 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). 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 relatively vulnerable to MF/HF sonar exposures. It has also been argued that traumas from some beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.,* 2003); however, there is no conclusive evidence of this (Rommel *et al.,* 2006). Based on examination of sonar-associated strandings, Bernaldo de Quiros *et al.* (2019) list diagnostic features, the presence of all of which suggest gas and fat embolic syndrome for beaked whales stranded in association with sonar exposure.

As described in additional detail in the Nitrogen Decompression subsection of the 2020 GOA DSEIS/OEIS, marine mammals generally are thought to deal with nitrogen loads in their blood and other tissues, caused by gas exchange from the lungs under conditions of high ambient pressure during diving, through anatomical, behavioral, and physiological adaptations (Hooker *et al.,* 2012). Although not a direct injury, variations in marine mammal diving behavior or avoidance responses have been hypothesized to result in nitrogen off-gassing in super-saturated tissues, possibly to the point of deleterious vascular and tissue bubble formation (Hooker *et al.,* 2012; Jepson *et al.,* 2003; Saunders *et al.,* 2008) with resulting symptoms similar to decompression sickness, however the process is still not well understood.

Fahlman *et al.* (2021) explained how stress can have a critical role in causing the gas emboli present in stranded cetaceans. The authors review decompression theory and the mechanisms dolphins have evolved to prevent high N_2 levels and gas emboli in normal conditions, and describe how, in times of high stress, the selective gas exchange hypothesis states that this mechanism can break down. In addition, circulating microparticles may be a useful biomarker for decompression stress in cetaceans. Velazquez-Wallraf *et al.* (2021) found that individual variation also has an essential role in this condition. To validate decompression sickness observations in certain stranded cetaceans found coincident with naval activities, the study used rabbits as an experimental pathological model and found that rabbit mortalities during or immediately following decompression showed systematically distributed gas bubbles (microscopic and macroscopic), as well as emphysema and hemorrhages in multiple organs, similar to observations in the stranded cetacean mortalities. Similar findings were not found in almost half the rabbits that survived at least one hour after decompression, revealing individual variation has an essential role in this condition.

In 2009, Hooker *et al.* tested two mathematical models to predict blood and tissue tension N_2 (P_{N2}) using field data from three beaked whale species: northern bottlenose whales, Cuvier's beaked whales, and Blainville's beaked whales. The researchers aimed to determine if physiology (body mass, diving lung volume, and dive response) or dive behavior (dive depth and duration, changes in ascent rate, and diel behavior) would lead to differences in P_{N2} levels and thereby decompression sickness risk between species. In their study, they compared results for previously published time depth recorder data (Hooker and Baird, 1999; Baird *et al.,* 2006, 2008) from Cuvier's beaked whale, Blainville's beaked whale, and northern bottlenose whale. They reported that diving lung volume and extent of the dive response had a large effect on end-dive P_{N2}. Also, results showed that dive profiles had a larger influence on end-dive P_{N2} than body mass differences between species. Despite diel changes (*i.e.,* variation that occurs regularly every day or most days) in dive behavior, P_{N2} levels showed no consistent trend. Model output suggested that all three species live with tissue P_{N2} levels that would cause a significant proportion of decompression sickness cases in terrestrial mammals. The authors concluded that the dive behavior of Cuvier's beaked whale was different from both Blainville's beaked whale and northern bottlenose whale, and resulted in higher predicted tissue and blood N_2 levels (Hooker *et al.,* 2009). They also suggested that the prevalence of Cuvier's beaked whales stranding after naval sonar exercises could be explained by either a higher abundance of this species in the affected areas or by possible species differences in behavior and/or physiology related to MF active sonar (Hooker *et al.,* 2009).

Bernaldo de Quiros *et al.* (2012) showed that, among stranded whales, deep diving species of whales had higher abundances of gas bubbles compared to shallow diving species. Kvadsheim *et al.* (2012) estimated blood and tissue P_{N2} levels in species representing shallow, intermediate, and deep diving cetaceans following behavioral responses to sonar and their comparisons found that deep diving species had higher end-dive blood and tissue N_2 levels, indicating a higher risk of developing gas bubble emboli compared with shallow diving species. Fahlmann *et al.* (2014) evaluated dive data recorded from sperm, killer, long-finned pilot, Blainville's beaked and Cuvier's beaked whales before and during exposure to low-frequency (1–2 kHz), as defined by the authors, and mid-frequency (2–7 kHz) active sonar in an attempt to determine if either differences in dive behavior or physiological responses to sonar are plausible risk factors for bubble formation. The authors suggested that CO_2 may initiate bubble formation and growth, while elevated levels of N_2 may be important for continued bubble growth. The authors also suggest that if CO_2 plays an important role in bubble formation, a cetacean escaping a sound source may experience increased metabolic rate, CO_2 production, and alteration in cardiac output, which could increase risk of gas bubble emboli. However, as discussed in Kvadsheim *et al.* (2012), the actual observed behavioral responses to sonar from the species in their study (sperm, killer, long-finned pilot, Blainville's beaked, and Cuvier's beaked whales) did not imply any significantly increased risk of decompression sickness due to high levels of N_2. Therefore, further information is needed to understand the relationship between exposure to stimuli, behavioral response (discussed in more detail below), elevated N_2 levels, and gas bubble emboli in marine mammals. The hypotheses for gas bubble formation related to beaked whale strandings is that beaked whales potentially have strong avoidance responses to MF active sonars because they sound similar to their main predator, the killer whale (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Baird *et al.,* 2008; Hooker *et al.,* 2009). Further investigation is needed to assess the potential validity of these hypotheses.

To summarize, while there are several hypotheses, there is little data directly connecting intense, anthropogenic underwater sounds with non-auditory physical effects in marine mammals. The available data do not support identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways. In addition, such effects, if they occur at all, would be expected to be limited to situations where marine mammals are exposed to high powered sounds at very close range over a prolonged period of time, which is not expected to occur based on the speed of the vessels operating sonar in combination with the speed and behavior of marine mammals in the vicinity of sonar.

Injury Due to Sonar-Induced Acoustic Resonance

An object exposed to its resonant frequency will tend to amplify its vibration at that frequency, a phenomenon called acoustic resonance. Acoustic resonance has been proposed as a potential mechanism by which a sonar or sources with similar operating characteristics could damage tissues of marine mammals. In 2002, NMFS convened a panel of government and private scientists to investigate the potential for acoustic resonance to occur in marine mammals (NOAA, 2002). They modeled and evaluated the likelihood that Navy mid-frequency sonar (2–10 kHz) caused resonance effects in beaked whales that eventually led to their stranding. The workshop participants concluded that resonance in air-filled structures was not likely to have played a primary role in the Bahamas stranding in 2000. They listed several reasons supporting this finding including (among others): tissue displacements at resonance are estimated to be too small to cause tissue damage; tissue-lined air spaces most susceptible to resonance are too large in marine mammals to have resonant frequencies in the ranges used by mid-frequency or low-frequency sonar; lung resonant frequencies increase with depth, and tissue displacements decrease with depth so if resonance is more likely to be caused at depth it is also less likely to have an affect there; and lung tissue damage has not been observed in any mass, multi-species stranding of beaked whales. The frequency at which resonance was predicted to occur in the animals' lungs was 50 Hz, well below the frequencies used by the mid-frequency sonar systems associated with the Bahamas event. The workshop participants focused on the March 2000 stranding of beaked whales in the Bahamas as high-quality data were available, but the workshop report notes that the results apply to other sonar-related stranding events. For the reasons given by the

2002 workshop participants, we do not anticipate injury due to sonar-induced acoustic resonance from the Navy's planned activities.

Physiological Stress

There is growing interest in monitoring and assessing the impacts of stress responses to sound in marine animals. 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.

According to Moberg (2000), 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 or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier and Rivest, 1991), altered metabolism (Elasser *et al.,* 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance (Moberg, 1987; Blecha, 2000). 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 serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impairs those functions that experience the diversion. For example, when a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When 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 of distress will last until the animal replenishes its energetic reserves sufficiently 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 are well-studied through controlled experiments in both laboratory and free-ranging 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). However, it should be noted (and as is described in additional detail in the 2020 GOA DSEIS/OEIS) that our understanding of the functions of various stress hormones (for example, cortisol), is based largely upon observations of the stress response in terrestrial mammals. Atkinson *et al.,* 2015 note that the endocrine response of marine mammals to stress may not be the same as that of terrestrial mammals because of the selective pressures marine mammals faced during their evolution in an ocean environment. For example, due to the necessity of breath-holding while diving and foraging at depth, the physiological role of epinephrine and norepinephrine (the catecholamines) in marine mammals might be different than in other mammals.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to disease and naturally occurring toxins, lack of prey availability, and interactions with predators all contribute to the stress a marine mammal experiences (Atkinson *et al.,* 2015). Breeding cycles, periods of fasting, and social interactions with members of the same species are also stressors, although they are natural components of an animal's life history. Anthropogenic activities have the potential to provide additional stressors beyond those that occur naturally (Fair *et al.,* 2014; Meissner *et al.,* 2015; Rolland *et al.,* 2012). Anthropogenic stressors potentially include such things as fishery interactions, pollution, tourism, and ocean noise.

Acoustically induced stress in marine mammals is not well understood. There are ongoing efforts to improve our understanding of how stressors impact marine mammal populations (*e.g.,* King *et al.,* 2015; New *et al.,* 2013a; New *et al.,* 2013b; Pirotta *et al.,* 2015a), however little data exist on the consequences of sound-induced stress response (acute or chronic). Factors potentially affecting a marine mammal's response to a stressor include the individual's life history stage, sex, age, reproductive status, overall physiological and behavioral plasticity, and whether they are naïve or experienced with the sound (*e.g.,* prior experience with a stressor may result in a reduced response due to habituation (Finneran and Branstetter, 2013; St. Aubin and Dierauf, 2001). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). For example, 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. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

Other research has also investigated the impact from vessels (both whale-watching and general vessel traffic noise), and demonstrated impacts do occur (Bain, 2002; Erbe, 2002; Lusseau, 2006; Williams *et al.,* 2006; Williams *et al.,* 2009; Noren *et al.,* 2009; Read *et al.,* 2014; Rolland *et al.,* 2012; Skarke *et al.,* 2014; Williams *et al.,* 2013; Williams *et al.,* 2014a; Williams *et al.,* 2014b; Pirotta *et al.,* 2015b). This body of research has generally investigated impacts associated with the presence of chronic stressors, which differ significantly from the proposed Navy training activities in the GOA Study Area. 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) 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. 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 (NRC, 2005). The Office of Naval Research hosted a workshop (Effects of Stress on Marine Mammals Exposed to Sound) in 2009 that focused on this topic (ONR, 2009). Ultimately, the PCAD working group issued a report (Cochrem, 2014) that summarized information compiled from 239 papers or book chapters relating to stress in marine mammals and concluded that stress responses can last from minutes to hours and, while we typically focus on adverse stress responses, stress response is part of a natural process to help animals adjust to changes in their environment and can also be either neutral or beneficial.

Most sound-induced stress response studies in marine mammals have focused on acute responses to sound either by measuring catecholamines or by measuring heart rate as an assumed proxy for an acute stress response. Belugas demonstrated no catecholamine response to the playback of oil drilling sounds (Thomas *et al.,* 1990) but showed a small but statistically significant increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano *et al.,* 2004). A bottlenose dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate a statistically significant elevation in aldosterone (Romano *et al.,* 2004), albeit the increase was within the normal daily variation observed in this species (St. Aubin *et al.,* 1996). Increases in heart rate were observed in bottlenose dolphins to which known calls of other dolphins were played, although no increase in heart rate was observed when background tank noise was played back (Miksis *et al.,* 2001). Unfortunately, in this study, it cannot be determined whether the increase in heart rate was due to stress or an anticipation of being reunited with the dolphin to which the vocalization belonged. Similarly, a young beluga's heart rate was observed to increase during exposure to noise, with increases dependent upon the frequency band of noise and duration of exposure, and with a sharp decrease to normal or below normal levels upon cessation of the exposure (Lyamin *et al.,* 2011). Spectral analysis of heart rate variability corroborated direct measures of heart rate (Bakhchina *et al.,* 2017). This response might have been in part due to the conditions during testing, the young age of the animal, and the novelty of the exposure; a year later the exposure was repeated at a slightly higher received level and there was no heart rate response, indicating the beluga whale may have acclimated to the noise exposure. Kvadsheim *et al.* (2010) measured the heart rate of captive hooded seals during exposure to sonar signals and found an increase in the heart rate of the seals during exposure periods versus control periods when the animals were at the surface. When the animals dove, the normal dive-related bradycardia (decrease in heart rate) was not impacted by the sonar exposure. Elmegaard *et al.* (2021) found that sonar sweeps did not elicit a startle response in captive harbor porpoises, but initial exposures induced bradycardia, whereas impulse exposures induced startle responses without a change in heart rate. The authors suggested that the parasympathetic cardiac dive response may override any transient sympathetic response, or that diving mammals may not have the cardiac startle response seen in terrestrial mammals in order to maintain volitional cardiovascular control at depth. Similarly, Thompson *et al.* (1998) observed a rapid but short-lived decrease in heart rates in harbor and grey seals exposed to seismic air guns (cited in Gordon *et al.,* 2003). Williams *et al.* (2017) monitored the heart rates of narwhals released from capture and found that a profound dive bradycardia persisted, even though exercise effort increased dramatically as part of their escape response following release. Thus, although some limited evidence suggests that tachycardia might occur as part of the acute stress response of animals that are at the surface, the dive bradycardia persists during diving and might be enhanced in response to an acute stressor. Yang *et al.* (2021) measured cortisol concentrations in two bottlenose dolphins and found significantly higher concentrations after exposure to 140 dB re 1 μPa impulsive noise playbacks. Two out of six tested indicators of immune system function underwent acoustic dose-dependent changes, suggesting that repeated exposures or sustained stress response to impulsive sounds may increase an affected individual's susceptibility to pathogens. However, exposing dolphins to a different acoustic stressor yielded contrasting results. Houser *et al.* (2020) measured cortisol and epinephrine obtained from 30 bottlenose dolphins exposed to simulated U.S. Navy mid-frequency sonar and found no correlation between SPL and stress hormone levels. In the same experiment (Houser *et al.,* 2013b), behavioral responses were shown to increase in severity with increasing received SPLs. These results suggest that behavioral reactions to sonar signals are not necessarily indicative of a hormonal stress response. Houser *et al.* (2020) notes that additional research is needed to determine the relationship between behavioral responses and physiological responses.

Despite the limited amount of data available on sound-induced stress responses for marine mammals exposed to anthropogenic sounds, studies of other marine animals and terrestrial animals would also lead us to expect that some marine mammals 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 *(e.g.,* elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiological stress responses of endangered Sonoran pronghorn to military overflights. However, take due to aircraft noise is not anticipated as a result of the Navy's activities. Smith *et al.* (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (*i.e.,* goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Auditory Masking

Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, or navigation) (Richardson *et al.,* 1995; Erbe and Farmer, 2000; Tyack, 2000; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. As described in detail in the 2020 GOA DSEIS/OEIS, the ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age, or TTS hearing loss), and existing ambient noise and propagation conditions. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations. Masking can lead to behavioral changes including vocal changes (*e.g.,* Lombard effect, increasing amplitude, or changing frequency), cessation of foraging, and leaving an area, to both signalers and receivers, in an attempt to compensate for noise levels (Erbe *et al.,* 2016).

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.

Under certain circumstances, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting natural behavioral patterns to the point where the behavior is abandoned or significantly altered. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which only occurs during the sound exposure. Because masking (without resulting in threshold shift) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

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 (including critical ratios, or the lowest signal-to-noise ratio in which animals can detect a signal, Finneran and Branstetter, 2013; Johnson *et al.,* 1989; Southall *et al.,* 2000) 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 frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.,* Clark *et al.,* 2009; Matthews *et al.,* 2016) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al.,* 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.,* Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.,* Branstetter *et al.,* 2013).

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 study by Nachtigall and Supin (2018) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

Impacts on signal detection, measured by masked detection thresholds, are not the only important factors to address when considering the potential effects of masking. As marine mammals use sound to recognize conspecifics, prey, predators, or other biologically significant sources (Branstetter *et al.,* 2016), it is also important to understand the impacts of masked recognition thresholds (often called ''informational masking''). Branstetter *et al.,* 2016 measured masked recognition thresholds for whistle-like sounds of bottlenose dolphins and observed that they are approximately 4 dB above detection thresholds (energetic masking) for the same signals. Reduced ability to recognize a conspecific call or the acoustic signature of a predator could have severe negative impacts. Branstetter *et al.,* 2016 observed that if ''quality communication'' is set at 90 percent recognition the output of communication space models (which are based on 50 percent detection) would likely result in a significant decrease in communication range.

As marine mammals use sound to recognize predators (Allen *et al.,* 2014; Cummings and Thompson, 1971; Curé *et al.,* 2015; Fish and Vania, 1971), the presence of masking noise may also prevent marine mammals from responding to acoustic cues produced by their predators, particularly if it occurs in the same frequency band. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by mammal-eating killer whales. The seals acoustically discriminate between the calls of mammal-eating and fish-eating killer whales (Deecke *et al.,* 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls. Similarly, sperm whales (Curé *et al.,* 2016; Isojunno *et al.,* 2016), long-finned pilot whales (Visser *et al.,* 2016), and humpback whales (Curé *et al.,* 2015) changed their behavior in response to killer whale vocalization playbacks; these findings indicate that some recognition of predator cues could be missed if the killer whale vocalizations were masked. The potential effects of masked predator acoustic cues depends on the duration of the masking noise and the likelihood of a marine mammal encountering a predator during the time that detection and recognition of predator cues are impeded.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio.

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from commercial vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Impaired Communication

In addition to making it more difficult for animals to perceive and recognize 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'' (or communication 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). 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 species 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 (repetition rate), or may cease to vocalize.

Many animals will combine several of these strategies to compensate for high levels of background noise. Although the fitness consequences of vocal adjustments are not directly known in all instances, like most other trade-offs animals must make, some of these strategies probably come at a cost (Patricelli *et al.,* 2006). Shifting songs and calls to higher frequencies may also impose energetic costs (Lambrechts, 1996). For example, in birds, 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).

Marine mammals are also known to make vocal changes in response to anthropogenic noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying (see the following for examples: Gordon *et al.,* 2003; Di Iorio and Clark, 2010; Hatch *et al.,* 2012; Holt *et al.,* 2008; Holt *et al.,* 2011; Lesage *et al.,* 1999; McDonald *et al.,* 2009; Parks *et al.,* 2007, Risch *et al.,* 2012, Rolland *et al.,* 2012), as well as changes in the natural acoustic environment (Caruso *et al.,* 2020; Dunlop *et al.,* 2014; Helble *et al.,* 2020). Vocal changes can be temporary, or can be persistent. For example, model simulation suggests that the increase in starting frequency for the North Atlantic right whale upcall over the last 50 years resulted in increased detection ranges between right whales. The frequency shift, coupled with an increase in call intensity by 20 dB, led to a call detectability range of less than 3 km to over 9 km (Tennessen and Parks, 2016). Holt *et al.* (2008) measured killer whale call source levels and background noise levels in the one to 40 kHz band and reported that the whales increased their call source levels by one dB SPL for every one dB SPL increase in background noise level. Similarly, another study on St. Lawrence River belugas reported a similar rate of increase in vocalization activity in response to passing vessels (Scheifele *et al.,* 2005). Di Iorio and Clark (2010) showed that blue whale calling rates vary in association with seismic sparker survey activity, with whales calling more on days with surveys than on days without surveys. They suggested that the whales called more during seismic survey periods as a way to compensate for the elevated noise conditions.

In some cases, these vocal changes may have fitness consequences, such as an increase in metabolic rates and oxygen consumption, as observed in bottlenose dolphins when increasing their call amplitude (Holt *et al.,* 2015). A switch from vocal communication to physical, surface-generated sounds such as pectoral fin slapping or breaching was observed for humpback whales in the presence of increasing natural background noise levels, indicating that adaptations to masking may also move beyond vocal modifications (Dunlop *et al.,* 2010).

While these changes all represent possible tactics by the sound-producing animal to reduce the impact of masking, the receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a quieter location, or reducing self-noise from hydrodynamic flow by remaining still. The temporal structure of noise (*e.g.,* amplitude modulation) may also provide a considerable release from masking through comodulation masking release (a reduction of masking that occurs when broadband noise, with a frequency spectrum wider than an animal's auditory filter bandwidth at the frequency of interest, is amplitude modulated) (Branstetter and Finneran, 2008; Branstetter *et al.,* 2013). Signal type (*e.g.,* whistles, burst-pulse, sonar clicks) and spectral characteristics (*e.g.,* frequency modulated with harmonics) may further influence masked detection thresholds (Branstetter *et al.,* 2016; Cunningham *et al.,* 2014).

Masking Due to Sonar and Other Transducers

The functional hearing ranges of mysticetes, odontocetes, and pinnipeds underwater overlap the frequencies of the sonar sources used in the Navy's low-frequency active sonar (LFAS)/mid-frequency active sonar (MFAS)/high-frequency active sonar (HFAS) training exercises (though the Navy proposes no LFAS use for the activities in this rulemaking). Additionally, almost all affected 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. Masking by mid-frequency active sonar (MFAS) with relatively low-duty cycles is not anticipated (or would be of very short duration) for most cetaceans as sonar signals occur over a relatively short duration and narrow bandwidth (overlapping with only a small portion of the hearing range). While dolphin whistles and MFAS are similar in frequency, masking is not anticipated (or would be of very short duration) due to the low-duty cycle of most sonars.

As described in the 2020 GOA DSEIS/OEIS, newer high-duty cycle or continuous active sonars have more potential to mask vocalizations. These sonars transmit more frequently (greater than 80 percent duty cycle) than traditional sonars, but at a substantially lower source level. HFAS, such as pingers that operate at higher repetition rates (*e.g.,* 2–10 kHz with harmonics up to 19 kHz, 76 to 77 pings per minute) (Culik *et al.,* 2001), also operate at lower source levels and have faster attenuation rates due to the higher frequencies used. These lower source levels limit the range of impacts, however compared to traditional sonar systems, individuals close to the source are likely to experience masking at longer time scales. The frequency range at which high-duty cycle systems operate overlaps the vocalization frequency of many mid-frequency cetaceans. Continuous noise at the same frequency of communicative vocalizations may cause disruptions to communication, social interactions, acoustically mediated cooperative behaviors, and important environmental cues. There is also the potential for the mid-frequency sonar signals to mask important environmental cues (*e.g.,* predator or conspecific acoustic cues), possibly affecting survivorship for targeted animals. Masking due to high duty cycle sonars is likely analogous to masking produced by other continuous sources (*e.g.,* vessel noise and low-frequency cetaceans), and would likely have similar short-term consequences, though longer in duration due to the duration of the masking noise. A study by von Benda-Beckmann *et al.* (2021) modeled the effect of pulsed and continuous 1–2 kHz active sonar on sperm whale echolocation clicks, and found that the presence of upper harmonics in the sonar signal increased masking of clicks produced in the search phase of foraging compared to buzz clicks produced during prey capture. Different levels of sonar caused intermittent to continuous masking (120 to 160 dB re 1 μPa2, respectively), but varied based on click level, whale orientation, and prey target strength. Continuous active sonar resulted in a greater percentage of time that echolocation clicks were masked compared to pulsed active sonar. Other short-term consequences may include changes to vocalization amplitude and frequency (Brumm and Slabbekoorn, 2005; Hotchkin and Parks, 2013) and behavioral impacts such as avoidance of the area and interruptions to foraging or other essential behaviors (Gordon *et al.,* 2003; Isojunno *et al.,* 2021). Long-term consequences could include changes to vocal behavior and vocalization structure (Foote *et al.,* 2004; Parks *et al.,* 2007), abandonment of habitat if masking occurs frequently enough to significantly impair communication (Brumm and Slabbekoorn, 2005), a potential decrease in survivorship if predator vocalizations are masked (Brumm and Slabbekoorn, 2005), and a potential decrease in recruitment if masking interferes with reproductive activities or mother-calf communication (Gordon *et al.,* 2003).

Masking Due to Vessel Noise

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as vessels. Several studies have shown decreases in marine mammal communication space and changes in behavior as a result of the presence of vessel noise. For example, right whales were 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) as well as increasing the amplitude (intensity) of their calls (Parks, 2009; Parks *et al.,* 2011). Fournet *et al.* (2018) observed that humpback whales in Alaska responded to increasing ambient sound levels (natural and anthropogenic) by increasing the source levels of their calls (non-song vocalizations). Clark *et al.* (2009) also observed that right whales communication space decreased by up to 84 percent in the presence of vessels (Clark *et al.,* 2009). Cholewiak *et al.* (2018) also observed loss in communication space in Stellwagen National Marine Sanctuary for North Atlantic right whales, fin whales, and humpback whales with increased ambient noise and shipping noise. Gabriele *et al.* (2018) modeled the effects of vessel traffic sound on communication space in Glacier Bay National Park in Alaska and found that typical summer vessel traffic in the National Park causes losses of communication space to singing whales (reduced by 13–28 percent), calling whales (18–51 percent), and roaring seals (32–61 percent), particularly during daylight hours and even in the absence of cruise ships. Dunlop (2019) observed that an increase in vessel noise reduced modelled communication space and resulted in significant reduction in group social interactions in Australian humpback whales. However, communication signal masking did not fully explain this change in social behavior in the model, indicating there may also be an additional effect of the physical presence of the vessel on social behavior (Dunlop, 2019). Although humpback whales off Australia did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected based on source level changes to wind noise, potentially indicating some signal masking (Dunlop, 2016). Multiple delphinid species have also been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic noise and reduced communication space (for examples see: Holt *et al.,* 2008; Holt *et al.,* 2011; Gervaise *et al.,* 2012; Williams *et al.,* 2013; Hermannsen *et al.,* 2014; Papale *et al.,* 2015; Liu *et al.,* 2017; Pine *et al.,* 2021).

Behavioral Response/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 predisposed 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), the 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; DeRuiter *et al.,* 2013). 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. For example, Goldbogen *et al.* (2013) demonstrated that individual behavioral state was critically important in determining response of blue whales to sonar, noting that some individuals engaged in deep (≤50 m) feeding behavior had greater dive responses than those in shallow feeding or non-feeding conditions. Some blue whales in the Goldbogen *et al.* (2013) study that were engaged in shallow feeding behavior demonstrated no clear changes in diving or movement even when received levels (RLs) were high (~160 dB re: 1µPa) for exposures to 3–4 kHz sonar signals, while others showed a clear response at exposures at lower received levels of sonar and pseudorandom noise.

Studies by DeRuiter *et al.* (2012) indicate that variability of responses to acoustic stimuli depends not only on the species receiving the sound and the sound source, but also on the social, behavioral, or environmental contexts of exposure. Another study by DeRuiter *et al.* (2013) examined behavioral responses of Cuvier's beaked whales to MF sonar and found that whales responded strongly at low received levels (RL of 89–127 dB re: 1µPa) by ceasing normal fluking and echolocation, swimming rapidly away, and extending both dive duration and subsequent non-foraging intervals when the sound source was 3.4–9.5 km away. Importantly, this study also showed that whales exposed to a similar range of received levels (78–106 dB re: 1 µPa) from distant sonar exercises (118 km away) did not elicit such responses, suggesting that context may moderate reactions.

Ellison *et al.* (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. The authors 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. Forney *et al.* (2017) also point out that an apparent lack of response (*e.g.,* no displacement or avoidance of a sound source) may not necessarily mean there is no cost to the individual or population, as some resources or habitats may be of such high value that animals may choose to stay, even when experiencing stress or hearing loss. Forney *et al.* (2017) recommend considering both the costs of remaining in an area of noise exposure such as TTS, PTS, or masking, which could lead to an increased risk of predation or other threats or a decreased capability to forage, and the costs of displacement, including potential increased risk of vessel strike, increased risks of predation or competition for resources, or decreased habitat suitable for foraging, resting, or socializing. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large spatial and temporal expanses. However, distance is one contextual factor for which data exist to quantitatively inform a take estimate, and the method for predicting Level B harassment in this rule does consider distance to the source. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure, where supporting information is available.

Friedlaender *et al.* (2016) provided the first integration of direct measures of prey distribution and density variables incorporated into across-individual analyses of behavior responses of blue whales to sonar, and demonstrated a five-fold increase in the ability to quantify variability in blue whale diving behavior. These results illustrate that responses evaluated without such measurements for foraging animals may be misleading, which again illustrates the context-dependent nature of the probability of response.

Exposure of marine mammals to sound sources can result in, but is not limited to, no response or any of the following observable responses: increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.,* 2007; Southall *et al.,* 2021). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). More recent reviews (Nowacek *et al.,* 2007; DeRuiter *et al.,* 2012 and 2013; Ellison *et al.,* 2012; Gomez *et al.,* 2016) address studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Gomez *et al.* (2016) conducted a review of the literature considering the contextual information of exposure in addition to received level and found that higher received levels were not always associated with more severe behavioral responses and vice versa. Southall *et al.* (2016) states that results demonstrate that some individuals of different species display clear yet varied responses, some of which have negative implications, while others appear to tolerate high levels, and that responses may not be fully predictable with simple acoustic exposure metrics (*e.g.,* received sound level). Rather, the authors state that differences among species and individuals along with contextual aspects of exposure (*e.g.,* behavioral state) appear to affect response probability.

Sperm whales were exposed to pulsed active sonar (1–2 kHz) at moderate source levels and high source levels, as well as continuously active sonar at moderate levels for which the summed energy (SEL) equaled the summed energy of the high source level pulsed sonar (Isojunno *et al.,* 2020). Foraging behavior did not change during exposures to moderate source level sonar, but non-foraging behavior increased during exposures to high source level sonar and to the continuous sonar, indicating that the energy of the sound (the SEL) was a better predictor of response than SPL. However, the time of day of the exposure was also an important covariate in determining the amount of non-foraging behavior, as were order effects (*e.g.* the SEL of the previous exposure). Isojunno *et al.* (2021) found that higher SELs reduced sperm whale buzzing (*i.e.,* foraging). Duration of continuous sonar activity also appears to impact sperm whale displacement and foraging activity (Stanistreet, 2022). During long bouts of sonar lasting up to 13 consecutive hours, occurring repeatedly over an 8 day naval exercise (median and maximum SPL = 120 dB and 164 dB), sperm whales substantially reduced how often they produced clicks during sonar, indicating a decrease or cessation in foraging behavior. Few previous studies have shown sustained changes in sperm whales, but there was an absence of sperm whale clicks for 6 consecutive days of sonar activity. Curé *et al.* (2021) also found that sperm whales exposed to continuous and pulsed active sonar were more likely to produce low or medium severity responses with higher cumulative SEL. Specifically, the probability of observing a low severity response increased to 0.5 at approximately 173 dB SEL and observing a medium severity response reached a probability of 0.35 at cumulative SELs between 179 and 189 dB. These results again demonstrate that the behavioral state and environment of the animal mediates the likelihood of a behavioral response, as do the characteristics (*e.g.,* frequency, energy level) of the sound source itself.

The following subsections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. 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, along with contextual factors.

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. The flight response differs from other avoidance responses in the intensity of the response (*e.g.,* directed movement, rate of travel). 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). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, being a component of marine mammal strandings associated with sonar activities (Evans and England, 2001). If marine mammals respond to Navy vessels that are transmitting active sonar in the same way that they might respond to a predator, their probability of flight responses should increase when they perceive that Navy vessels are approaching them directly, because a direct approach may convey detection and intent to capture (Burger and Gochfeld, 1981, 1990; Cooper, 1997, 1998). There are limited data on flight response for marine mammals in water; however, there are examples of this response in species on land. For instance, the probability of flight responses in Dall's sheep *Ovis dalli dalli* (Frid, 2001), hauled-out ringed seals *Phoca hispida* (Born *et al.,* 1999), Pacific brant (*Branta bernicl nigricans*), and Canada geese (*B. canadensis*) increased as a helicopter or fixed-wing aircraft more directly approached groups of these animals (Ward *et al.,* 1999). Bald eagles (*Haliaeetus leucocephalus*) perched on trees alongside a river were also more likely to flee from a paddle raft when their perches were closer to the river or were closer to the ground (Steidl and Anthony, 1996).

Response to Predator

As discussed earlier, 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.

Alteration of Diving or Movement

Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.* 2004; Goldbogen *et al.,* 2013a, 2013b). 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). Arranz *et al.* (2021) attempted to distinguish effects of vessel noise from vessel presence by conducting a noise exposure experiment which compared behavioral reactions of resting short-finned pilot whale mother-calf pairs during controlled approaches by a tour boat with two electric (136–140 dB) or petrol engines (139–150 dB). Approach speed (<4 knots), distance of passes (60 m), and vessel features other than engine noise remained the same between the two experimental conditions. Behavioral data was collected via unmanned aerial vehicle and activity budgets were calculated from continuous focal follows. Mother pilot whales rested less and calves nursed less in response to both types of boat engines compared to control conditions (vessel >300 m, stationary in neutral). However, they found no significant impact on whale behaviors when the boat approached with the quieter electric engine, while resting behavior decreased 29 percent and nursing decreased 81 percent when the louder petrol engine was installed in the same vessel. 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. Lastly, as noted previously, DeRuiter *et al.* (2013) noted that distance from a sound source may moderate marine mammal reactions in their study of Cuvier's beaked whales, which showed the whales swimming rapidly and silently away when a sonar signal was 3.4–9.5 km away while showing no such reaction to the same signal when the signal was 118 km away even though the received levels were similar.

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. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.,* 2001; Harris *et al.,* 2017; Madsen *et al.,* 2006a; Nowacek *et al.;* 2004; Yazvenko *et al.,* 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Southall *et al.* (2019a) found that prey availability was higher in the western area of the Southern California Offshore Range where Cuvier's beaked whales preferentially occurred, while prey resources were lower in the eastern area and moderate in the area just north of the Range. This high prey availability may indicate that fewer foraging dives are needed to meet metabolic energy requirements than would be needed in another area with fewer resources. Benoit-Bird *et al.* (2020) demonstrated that differences in squid distribution could be a substantial factor for beaked whales' habitat preference. The researchers suggest that this be considered when comparing beaked whale habitat use both on and off Navy ranges.

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). Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to air gun arrays at received levels in the range of 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.,* 2006a; Miller *et al.,* 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the air guns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were six percent lower during exposure than control periods (Miller *et al.,* 2009). These data raise concerns that air gun surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.,* 2009).

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 SPLs 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 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, Melcón *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 behavioral response studies 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 generally brief, of low to moderate severity, and highly dependent on exposure context (Southall *et al.,* 2011; Southall *et al.,* 2012b; Southall *et al.,* 2019b). 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 will help better inform a determination of whether foraging disruptions incur fitness consequences. Surface feeding blue whales did not show a change in behavior in response to mid-frequency simulated and real sonar sources with received levels between 90 and 179 dB re: 1 μPa, but deep feeding and non-feeding whales showed temporary reactions including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior. The behavioral responses the researchers observed were generally brief, of low to moderate severity, and highly dependent on exposure context (behavioral state, source-to-whale horizontal range, and prey availability) (DeRuiter *et al.,* 2017; Goldbogen *et al.,* 2013b; Sivle *et al.,* 2015). Goldbogen *et al.* (2013b) 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.

Similarly, while the rates of foraging lunges decrease in humpback whales due to sonar exposure, there was variability in the response across individuals, with one animal ceasing to forage completely and another animal starting to forage during the exposure (Sivle *et al.,* 2016). In addition, almost half of the animals that exhibited avoidance behavior were foraging before the exposure but the others were not; the animals that exhibited avoidance behavior while not feeding responded at a slightly lower received level and greater distance than those that were feeding (Wensveen *et al.,* 2017). These findings indicate that the behavioral state of the animal plays a role in the type and severity of a behavioral response. In fact, when the prey field was mapped and used as a covariate in similar models looking for a response in the same blue whales, the response in deep-feeding behavior by blue whales was even more apparent, reinforcing the need for contextual variables to be included when assessing behavioral responses (Friedlaender *et al.,* 2016).

Breathing

Respiration naturally varies 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). Harbor porpoises did not respond to the low-duty cycle mid-frequency tones at any received level, but one did respond to the high-duty cycle signal with more jumping and increased respiration rates (Kastelein *et al.,* 2018b). Harbor porpoises responded to seal scarers with broadband signals up to 44 kHz with a slight respiration response at 117 dB re 1 μPa and an avoidance response at 139 dB re 1 μPa, but another scarer with a fundamental (strongest) frequency of 18 kHz did not have an avoidance response until 151 dB re 1 μPa (Kastelein *et al.,* 2015e). 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. Lastly, Kastelein *et al.* (2019a) examined the potential masking effect of high sea state ambient noise on captive harbor porpoise perception of and response to high duty cycle playbacks of AN/SQS–53C sonar signals by observing their respiration rates. Results indicated that sonar signals were not masked by the high sea state noise, and received levels at which responses were observed were similar to those observed in prior studies of harbor porpoise behavior.

Pilot whales exhibited reduced breathing rates relative to their diving behavior when the low frequency active sonar levels were high (reaching 180 dB re 1 μPa), but only on the first sonar exposure; on subsequent exposures their breathing rates increased (Isojunno *et al.,* 2018), indicating a change in response tactic with additional exposures.

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.,* avoidance, masking, *etc.*). Sperm whales responded to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent, and becoming difficult to approach (Watkins *et al.,* 1985). In contrast, sperm whales in the Mediterranean that were exposed to submarine sonar continued calling (J. Gordon pers. comm. cited in Richardson *et al.,* 1995). Long-finned pilot whales exposed to three types of disturbance—playbacks of killer whale sounds, naval sonar exposure, and tagging—resulted in increased group sizes (Visser *et al.,* 2016). In response to sonar, pilot whales also spent more time at the surface with other members of the group (Visser *et al.,* 2016). However, social disruptions must be considered in context of the relationships that are affected. While some disruptions may not have deleterious effects, others, such as long-term or repeated disruptions of mother/calf pairs or interruption of mating behaviors, have the potential to affect the growth and survival or reproductive effort/success of individuals.

Vocalizations (Also see Auditory 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 in vocalization behavior that may result in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect an increased vigilance or a startle response. For example, in the presence of potentially masking signals (low-frequency active sonar), humpback whales have been observed to increase the length of their songs (Miller *et al.,* 2000; Fristrup *et al.,* 2003). 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; Rolland *et al.,* 2012). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (*e.g.,* whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote *et al.,* 2004; NOAA, 2014). 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.

Cerchio *et al.* (2014) used passive acoustic monitoring to document the presence of singing humpback whales off the coast of northern Angola and to opportunistically test for the effect of seismic survey activity on the number of singing whales. Two recording units were deployed between March and December 2008 in the offshore environment; numbers of singers were counted every hour. Generalized Additive Mixed Models were used to assess the effect of survey day (seasonality), hour (diel variation), moon phase, and received levels of noise (measured from a single pulse during each ten-minute sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale communication was disrupted to some extent by the survey activity.

Castellote *et al.* (2012) reported acoustic and behavioral changes by fin whales in response to shipping and air gun noise. Acoustic features of fin whale song notes recorded in the Mediterranean Sea and northeast Atlantic Ocean were compared for areas with different shipping noise levels and traffic intensities and during an air gun survey. During the first 72 hours of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of a Navy study area. This displacement persisted for a time period well beyond the 10-day duration of air gun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

Seismic pulses at average received levels of 131 dB re 1 μPa^2-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). Blackwell *et al.* (2013) found that bowhead whale call rates dropped significantly at onset of air gun use at sites with a median distance of 41–45 km from the survey. Blackwell *et al.* (2015) expanded this analysis to show that whales actually increased calling rates as soon as air gun signals were detectable before ultimately decreasing calling rates at higher received levels (*i.e.,* 10-minute cumulative sound exposure level (cSEL) of ~127 dB). Overall, these results suggest that bowhead whales may adjust their vocal output in an effort to compensate for noise before ceasing vocalization effort and ultimately deflecting from the acoustic source (Blackwell *et al.,* 2013, 2015). Captive bottlenose dolphins sometimes vocalized after an exposure to impulse sound from a seismic water gun (Finneran *et al.,* 2010a). These studies demonstrate that even low levels of noise received far from the noise source can induce changes in vocalization and/or behavioral responses.

Avoidance

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors. Richardson *et al.* (1995) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. Avoidance is qualitatively different from the flight response, but also differs in the magnitude of the response (*i.e.,* directed movement, rate of travel, *etc.*). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. 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; Kastelein *et al.,* 2015d; Kastelein *et al.,* 2015e; Kastelein *et al.,* 2018b). 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; Hiley *et al.,* 2021) and to some extent in mysticetes (Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Blackwell *et al.,* 2004; Bejder *et al.,* 2006; Teilmann *et al.,* 2006). 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). Gray whales have been reported deflecting from customary migratory paths in order to avoid noise from air gun surveys (Malme *et al.,* 1984). Humpback whales showed avoidance behavior in the presence of an active air gun array during observational studies and controlled exposure experiments in western Australia (McCauley *et al.,* 2000a).

As discussed earlier, Forney *et al.* (2017) detailed the potential effects of noise on marine mammal populations with high site fidelity, including displacement and auditory masking, noting that a lack of observed response does not imply absence of fitness costs and that apparent tolerance of disturbance may have population-level impacts that are less obvious and difficult to document. Avoidance of overlap between disturbing noise and areas and/or times of particular importance for sensitive species may be critical to avoiding population-level impacts because (particularly for animals with high site fidelity) there may be a strong motivation to remain in the area despite negative impacts. Forney *et al.* (2017) stated that, for these animals, remaining in a disturbed area may reflect a lack of alternatives rather than a lack of effects. The authors discuss several case studies, including western Pacific gray whales, which are a small population of mysticetes believed to be adversely affected by oil and gas development off Sakhalin Island, Russia (Weller *et al.,* 2002; Reeves *et al.,* 2005). Western gray whales display a high degree of interannual site fidelity to the area for foraging purposes, and observations in the area during air gun surveys have shown the potential for harm caused by displacement from such an important area (Weller *et al.,* 2006; Johnson *et al.,* 2007). Forney *et al.* (2017) also discuss beaked whales, noting that anthropogenic effects in areas where they are resident could cause severe biological consequences, in part because displacement may adversely affect foraging rates, reproduction, or health, while an overriding instinct to remain could lead to more severe acute effects.

In 1998, the Navy conducted a Low Frequency Sonar Scientific Research Program (LFS SRP) specifically to study behavioral responses of several species of marine mammals to exposure to LF sound, including one phase that focused on the behavior of gray whales to low frequency sound signals. The objective of this phase of the LFS SRP was to determine whether migrating gray whales respond more strongly to received levels, sound gradient, or distance from the source, and to compare whale avoidance responses to a LF source in the center of the migration corridor versus in the offshore portion of the migration corridor. A single source was used to broadcast LFAS sounds at received levels of 170–178 dB re: 1 µPa. The Navy reported that the whales showed some avoidance responses when the source was moored one mile (1.8 km) offshore, and located within the migration path, but the whales returned to their migration path when they were a few kilometers beyond the source. When the source was moored two miles (3.7 km) offshore, responses were much less, even when the source level was increased to achieve the same received levels in the middle of the migration corridor as whales received when the source was located within the migration corridor (Clark *et al.,* 1999). In addition, the researchers noted that the offshore whales did not seem to avoid the louder offshore source.

Also during the LFS SRP, researchers sighted numerous odontocete and pinniped species in the vicinity of the sound exposure tests with LFA sonar. The MF and HF hearing specialists present in California and Hawaii showed no immediately obvious responses or changes in sighting rates as a function of source conditions. Consequently, the researchers concluded that none of these species had any obvious behavioral reaction to LFA sonar signals at received levels similar to those that produced only minor short-term behavioral responses in the baleen whales (*i.e.,* LF hearing specialists). Thus, for odontocetes, the chances of injury and/or significant behavioral responses to LFA sonar would be low given the MF/HF specialists' observed lack of response to LFA sounds during the LFS SRP and due to the MF/HF frequencies to which these animals are adapted to hear (Clark and Southall, 2009).

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 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 at 1–2 kHz every 10 seconds for 10 minutes; Source B: with a 1.0 second upsweep 197 dB at 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, where killer whales cooperatively herd fish schools into a tight ball towards the surface and feed on the fish which have been stunned by tailslaps, and subsurface feeding (Simila, 1997) ceased feeding during the approach of the sonar and moved rapidly away from the source. When exposed to Source B, Kvadsheim *et al.* (2007) 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.

Southall *et al.* (2007) 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 and 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 no quantitative criteria were recommended for behavioral responses. 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 are considered non-pulse sounds. 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 (referenced and summarized in the following paragraphs).

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 active sonar) 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, 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 re: 1 μPa 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 active sonar) 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 re: 1 μPa, while in other cases these responses were not seen in the 120 to 150 dB re: 1 μPa 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 active sonar) 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 re: 1 μPa), at least for initial exposures. All recorded exposures above 140 dB re: 1 μPa 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 are 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 including: AHDs, ATOC, various non-pulse sounds used in underwater data communication, underwater drilling, and construction noise. Few studies existed with enough information to include them in the analysis. The limited data suggested that exposures to non-pulse sounds between 90 and 140 dB re: 1 μPa generally do not result in strong behavioral responses in pinnipeds in water, but no data exist at higher received levels.

In 2007, the first in a series of behavioral response studies (BRS) on deep diving odontocetes conducted by NMFS, Navy, and other scientists showed one Blainville's beaked whale 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 MF 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 re: 1μ Pa). This sensitivity was manifested 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 of the MFAS transmission. The response to such stimuli appears to involve the beaked whale increasing the distance between it and the sound source. Overall the results from the 2007–2008 study showed a change in diving behavior of the Blainville's beaked whale to playback of MFAS and predator sounds (Boyd *et al.,* 2008; Southall *et al.,* 2009; Tyack *et al.,* 2011).

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.

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 were 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 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 respond 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 MF 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 one 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).

In the 2010 BRS study, researchers again used controlled exposure experiments to carefully measure behavioral responses of individual animals to sound exposures of MFAS and pseudo-random noise. For each sound type, some exposures were conducted when animals were in a surface feeding (approximately 164 ft (50 m) or less) and/or socializing behavioral state and others while animals were in a deep feeding (greater than 164 ft (50 m)) and/or traveling mode. The researchers conducted the largest number of controlled exposure experiments on blue whales (n=19) and of these, 11 controlled exposure experiments involved exposure to the MFAS sound type. For the majority of controlled exposure experiment transmissions of either sound type, they noted few obvious behavioral responses detected either by the visual observers or on initial inspection of the tag data. The researchers observed that throughout the controlled exposure experiment transmissions, up to the highest received sound level (absolute RMS value approximately 160 dB re: 1 μPa with signal-to-noise ratio values over 60 dB), two blue whales continued surface feeding behavior and remained at a range of around 3,820 ft (1,000 m) from the sound source (Southall *et al.,* 2011). In contrast, another blue whale (later in the day and greater than 11.5 mi (18.5 km; 10 nmi) from the first controlled exposure experiment location) exposed to the same stimulus (MFA) while engaged in a deep feeding/travel state exhibited a different response. In that case, the blue whale responded almost immediately following the start of sound transmissions when received sounds were just above ambient background levels (Southall *et al.,* 2011). The authors note that this kind of temporary avoidance behavior was not evident in any of the nine controlled exposure experiments involving blue whales engaged in surface feeding or social behaviors, but was observed in three of the ten controlled exposure experiments for blue whales in deep feeding/travel behavioral modes (one involving MFA sonar; two involving pseudo-random noise) (Southall *et al.,* 2011). The results of this study, as well as the results of the DeRuiter *et al.* (2013b) study of Cuvier's beaked whales discussed above, further illustrate the importance of behavioral context in understanding and predicting behavioral responses.

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 instrumented 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.

Southall *et al.* (2016) indicates that results from Tyack *et al.* (2011), Miller *et al.* (2015), Stimpert *et al.* (2014), and DeRuiter *et al.* (2013b) beaked whale studies demonstrate clear, strong, and pronounced but varied behavioral changes including avoidance with associated energetic swimming and cessation of individual foraging dives at quite low received levels (~100 to 135 dB re: 1 μPa) for exposures to simulated or active MF military sonars (1–8 kHz) with sound sources approximately 2–5 km away. Similar responses by beaked whales to sonar have been documented by Stimpert *et al.* (2014), Falcone *et al.* (2017), DiMarzio *et al.* (2018), and Joyce *et al.* (2019). Jones-Todd *et al.* (2021) developed a discrete-space, continuous-time analysis to estimate animal occurrence and unique movement probability into and out of an area over time, in response to sonar. They argue that existing models in the field are inappropriate for estimating a whale's exposure to sonar longitudinally and across multiple exercises; most models treat each day independently and don't consider repeated exposures over longer periods. This model also allows for individual variation in movement data. Using seven tagged Blainville's beaked whales' telemetry data, the model showed transition rates across an area's borders changing in response to sonar exposure, reflecting an avoidance response that lasted approximately 3 days after the end of the exposure. However, there are a number of variables influencing response or non-response including source distance (close vs. far), received sound levels, and other contextual variables such as other sound sources (*e.g.,* vessels, *etc.*) (Manzano-Roth *et al.,* 2016; Falcone *et al.,* 2017; Harris *et al.,* 2018). Wensveen *et al.* (2019) found northern bottlenose whales to avoid sonar out to distances of 28 km, but these distances are well in line with those observed on Navy ranges (Manzano-Roth *et al.,* 2016; Joyce *et al.,* 2019) where the animals return once the sonar has ceased. When exposed to especially long durations of naval sonar (up to 13 consecutive hours, repeatedly over 8 days), Cuvier's beaked whale detection rates remained low even 7 days after the exercise. In addition, a Mesoplodont beaked whale species was entirely displaced from the area during and at least 7 days after the sonar activity (Stanistreet *et al.,* 2022). Furthermore, beaked whales have also shown response to other non-sonar anthropogenic sounds such as commercial shipping and echosounders (Soto *et al.,* 2006; Pirotta *et al.,* 2012; Cholewiak *et al.,* 2017). Pirotta *et al.* (2012) documented broadband ship noise causing a significant change in beaked whale behavior up to at least 5.2 km away from the vessel. Even though beaked whales appear to be sensitive to anthropogenic sounds, the level of response at the population level does not appear to be significant based on over a decade of research at two heavily used Navy training areas in the Pacific (Falcone *et al.,* 2012; Schorr *et al.,* 2014; DiMarzio *et al.,* 2018; Schorr *et al.,* 2019). With the exception of seasonal patterns, DiMarzio *et al.* (2018) did not detect any changes in annual Cuvier's beaked whale abundance estimates in Southern California derived from passive acoustic echolocation detections over 9 years (2010–2018). Similar results for Blainville's beaked whales abundance estimates over several years was documented in Hawaii (Henderson *et al.,* 2016; DiMarzio *et al.,* 2018). Visually, there have been documented repeated sightings in southern California of the same individual Cuvier's beaked whales over 10 years, sightings of mother-calf pairs, and sightings of the same mothers with their second calf (Falcone *et al.,* 2012; Schorr *et al.,* 2014; Schorr *et al.,* 2019; Schorr, unpublished data).

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 United States 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). 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.

The strongest baleen whale response in any behavioral response study was observed in a minke whale in the 3S2 study, which responded at 146 dB re: 1 μPa by strongly avoiding the sound source (Kvadsheim *et al.,* 2017; Sivle *et al.,* 2015). Although the minke whale increased its swim speed, directional movement, and respiration rate, none of these were greater than rates observed in baseline behavior, and its dive behavior remained similar to baseline dives. A minke whale tagged in the Southern California behavioral response study also responded by increasing its directional movement, but maintained its speed and dive patterns, and so did not demonstrate as strong of a response (Kvadsheim *et al.,* 2017). In addition, the 3S2 minke whale demonstrated some of the same avoidance behavior during the controlled ship approach with no sonar, indicating at least some of the response was to the vessel (Kvadsheim *et al.,* 2017). Martin *et al.* (2015) found that the density of calling minke whales was reduced during periods of Navy training involving sonar relative to the periods before training, and increased again in the days after training was completed. The responses of individual whales could not be assessed, so in this case it is unknown whether the decrease in calling animals indicated that the animals left the range, or simply ceased calling. Similarly, minke whale detections made using Marine Acoustic Recording Instruments off Jacksonville, FL, were reduced or ceased altogether during periods of sonar use (Simeone *et al.,* 2015; U.S. Department of the Navy, 2013b), especially with an increased ping rate (Charif *et al.,* 2015). Harris *et al.* (2019b) utilized acoustically generated minke whale tracks at the U.S. Navy's Pacific Missile Range Facility to statistically demonstrate changes in the spatial distribution of minke whale acoustic presence before, during, and after surface ship mid-frequency active sonar training. The spatial distribution of probability of acoustic presence was different in the ''During'' phase compared to the ''Before'' phase, and the probability of presence at the center of ship activity for the ''During'' phase was close to zero for both years. The ''After'' phases for both years retained lower probabilities of presence, suggesting the return to baseline conditions may take more than 5 days. While the results show a clear spatial redistribution of calling minke whales during surface ship mid-frequency active sonar training, a limitation of passive acoustic monitoring is that one cannot conclude if the whales moved away, went silent, or a combination of the two.

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.

Continued Pre-Disturbance Behavior and Habituation

Under some circumstances, some of the individual marine mammals that are exposed to active sonar transmissions will continue their normal behavioral activities. In other circumstances, individual animals will respond to sonar transmissions at lower received levels and move to avoid additional exposure or exposures at higher received levels (Richardson *et al.,* 1995).

It is difficult to distinguish between animals that continue their pre-disturbance behavior without stress responses, animals that continue their behavior but experience stress responses (that is, animals that cope with disturbance), and animals that habituate to disturbance (that is, they may have experienced low-level stress responses initially, but those responses abated over time). Watkins (1986) reviewed data on the behavioral reactions of fin, humpback, right, and minke whales that were exposed to continuous, broadband low-frequency shipping and industrial noise in Cape Cod Bay. He concluded that underwater sound was the primary cause of behavioral reactions in these species of whales and that the whales responded behaviorally to acoustic stimuli within their respective hearing ranges. Watkins also noted that whales showed the strongest behavioral reactions to sounds in the 15 Hz to 28 kHz range, although negative reactions (avoidance, interruptions in vocalizations, *etc.*) were generally associated with sounds that were either unexpected, too loud, suddenly louder or different, or perceived as being associated with a potential threat (such as an approaching ship on a collision course). In particular, whales seemed to react negatively when they were within 100 m of the source or when received levels increased suddenly in excess of 12 dB relative to ambient sounds. At other times, the whales ignored the source of the signal and all four species habituated to these sounds. Nevertheless, Watkins concluded that whales ignored most sounds in the background of ambient noise, including sounds from distant human activities even though these sounds may have had considerable energies at frequencies well within the whales' range of hearing. Further, he noted that of the whales observed, fin whales were the most sensitive of the four species, followed by humpback whales; right whales were the least likely to be disturbed and generally did not react to low-amplitude engine noise. By the end of his period of study, Watkins (1986) concluded that fin and humpback whales had generally habituated to the continuous and broad-band noise of Cape Cod Bay while right whales did not appear to change their response. As mentioned above, animals that habituate to a particular disturbance may have experienced low-level stress responses initially, but those responses abated over time. In most cases, this likely means a lessened immediate potential effect from a disturbance. However, there is cause for concern where the habituation occurs in a potentially more harmful situation. For example, animals may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.,* 1993; Wiley *et al.,* 1995).

Aicken *et al.* (2005) monitored the behavioral responses of marine mammals to a new low-frequency active sonar system used by the British Navy (which would be considered mid-frequency active sonar under this rule as it operates at frequencies greater than 1,000 Hz). During those trials, fin whales, sperm whales, Sowerby's beaked whales, long-finned pilot whales, Atlantic white-sided dolphins, and common bottlenose dolphins were observed and their vocalizations were recorded. These monitoring studies detected no evidence of behavioral responses that the investigators could attribute to exposure to the low-frequency active sonar during these trials.

Explosive 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). 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). 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 (see the *Hearing Loss—Threshold Shift* section). 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).

Further Potential Effects of Behavioral Disturbance on Marine Mammal Fitness

The different ways that marine mammals respond to sound are sometimes indicators of the ultimate effect that exposure to a given stimulus will have on the well-being (survival, reproduction, *etc.*) of an animal. There are few quantitative marine mammal data relating the exposure of marine mammals to sound to effects on reproduction or survival, though data exists for terrestrial species to which we can draw comparisons for marine mammals. Several authors have reported that disturbance stimuli may cause animals to abandon nesting and foraging sites (Sutherland and Crockford, 1993); may cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan *et al.,* 1996; Feare, 1976; Mullner *et al.,* 2004); or may cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill, 2002). Each of these studies addressed the consequences of animals shifting from one behavioral state (*e.g.,* resting or foraging) to another behavioral state (*e.g.,* avoidance or escape behavior) because of human disturbance or disturbance stimuli.

One consequence of behavioral avoidance results in the altered energetic expenditure of marine mammals because energy is required to move and avoid surface vessels or the sound field associated with active sonar (Frid and Dill, 2002). Most animals can avoid that energetic cost by swimming away at slow speeds or speeds that minimize the cost of transport (Miksis-Olds, 2006), as has been demonstrated in Florida manatees (Miksis-Olds, 2006).

Those energetic costs increase, however, when animals shift from a resting state, which is designed to conserve an animal's energy, to an active state that consumes energy the animal would have conserved had it not been disturbed. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting to active behavioral states, which would imply that they incur an energy cost.

Morete *et al.* (2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling). When vessels approached, the amount of time cows and calves spent resting and milling, respectively, declined significantly. These results are similar to those reported by Scheidat *et al.* (2004) for the humpback whales they observed off the coast of Ecuador.

Constantine and Brunton (2001) reported that bottlenose dolphins in the Bay of Islands, New Zealand, engaged in resting behavior just 5 percent of the time when vessels were within 300 m, compared with 83 percent of the time when vessels were not present. However, Heenehan *et al.* (2016) report that results of a study of the response of Hawaiian spinner dolphins to human disturbance suggest that the key factor is not the sheer presence or magnitude of human activities, but rather the directed interactions and dolphin-focused activities that elicit responses from dolphins at rest. This information again illustrates the importance of context in regard to whether an animal will respond to a stimulus. Miksis-Olds (2006) and Miksis-Olds *et al.* (2005) reported that Florida manatees in Sarasota Bay, Florida, reduced the amount of time they spent milling and increased the amount of time they spent feeding when background noise levels increased. Although the acute costs of these changes in behavior are not likely to exceed an animal's ability to compensate, the chronic costs of these behavioral shifts are uncertain.

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called ''attentional capture'' occurs when a stimulus (usually a stimulus that an animal is not concentrating on or attending to) ''captures'' an animal's attention. This shift in attention can occur consciously or 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 or resting. These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). Animals will spend more time being vigilant (which may translate to less time foraging or resting) when disturbance stimuli approach an animal more directly, remain at closer distances, have a greater group size (*e.g.,* multiple surface vessels), or co-occur with times that an animal perceives increased risk (*e.g.,* when they are giving birth or accompanied by a calf). An example of this concept with terrestrial species involved bighorn sheep and Dall's sheep, which dedicated more time being vigilant, and less time resting or foraging, when aircraft made direct approaches over them (Frid, 2001; Stockwell *et al.,* 1991). Vigilance has also been documented in pinnipeds at haul-out sites where resting may be disturbed when seals become alerted and/or flush into the water due to a variety of disturbances, which may be anthropogenic (noise and/or visual stimuli) or due to other natural causes such as other pinnipeds (Richardson *et al.,* 1995; Southall *et al.,* 2007; VanBlaricom, 2010; Lozano and Hente, 2014).

Chronic disturbance can cause population declines through reduction of fitness (*e.g.,* decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.,* Harrington and Veitch, 1992; Daan *et al.,* 1996; Bradshaw *et al.,* 1998). For example, Madsen (1994) reported that pink-footed geese (*Anser brachyrhynchus*) in undisturbed habitat gained body mass and had about a 46 percent reproductive success rate compared with geese in disturbed habitat (being consistently scared off the fields on which they were foraging) which did not gain mass and had a 17 percent reproductive success rate. Similar reductions in reproductive success have been reported for mule deer (*Odocoileus hemionus*) disturbed by all-terrain vehicles (Yarmoloy *et al.,* 1988), caribou (*Rangifer tarandus caribou*) disturbed by seismic exploration blasts (Bradshaw *et al.,* 1998), and caribou disturbed by low-elevation military jet fights (Luick *et al.,* 1996; Harrington and Veitch, 1992). Similarly, a study of elk (*Cervus elaphus*) that were disturbed experimentally by pedestrians concluded that the ratio of young to mothers was inversely related to disturbance rate (Phillips and Alldredge, 2000). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period in open-air, open-water enclosures in San Diego Bay did not cause any sleep deprivation or stress effects such as changes in cortisol or epinephrine levels.

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 while decreasing their caloric intake/energy). An example of this concept with terrestrial species involved a study of grizzly bears (*Ursus horribilis*) that reported that bears disturbed by hikers reduced their energy intake by an average of 12 kilocalories/min (50.2 x 103 kiloJoules/min), and spent energy fleeing or acting aggressively toward hikers (White *et al.,* 1999). In a separate study, by integrating different sources of data (*e.g.,* controlled exposure data, activity monitoring, telemetry tracking, and prey sampling) into a theoretical model to predict effects from sonar on a blue whale's daily energy intake, Pirotta *et al.* (2021) found that tagged blue whales' activity budgets, lunging rates, and ranging patterns caused variability in their predicted cost of disturbance.

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 Shark 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 a 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). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant for fitness if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). It is important to note the difference between behavioral reactions lasting or recurring over multiple days and anthropogenic activities lasting or recurring over multiple days. For example, just because at-sea exercises last for multiple days does not necessarily mean that individual animals will be either exposed to those activity-related stressors (*i.e.,* sonar) for multiple days or further, exposed in a manner that would result in sustained multi-day substantive behavioral responses.

Stone (2015a) reported data from at-sea observations during 1,196 airgun surveys from 1994 to 2010. When large arrays of airguns (considered in this study to be 500 in^3 or more) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior, with indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding less often when large arrays were active. Monitoring of gray whales during an air gun survey included recording whale movements and respirations pre-, during-, and post-seismic survey (Gailey *et al.,* 2016). Behavioral state and water depth were the best ''natural'' predictors of whale movements and respiration and, after considering natural variation, none of the response variables were significantly associated with survey or vessel sounds.

In order to understand how the effects of activities may or may not impact species and stocks 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-level effects. 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. In this framework, behavioral and physiological changes can 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; 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; or they can have no effect to vital rates (New *et al.,* 2014). In addition to outlining this general framework and compiling the relevant literature that supports it, the authors chose 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 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 for the majority of species, as well as requiring significant resources and time to conduct (more than is typically available to support regulatory compliance for one project), they are a critical first step towards being able to quantify the likelihood of a population level effect.

Since New *et al.* (2014), several publications have described models developed to examine the long-term effects of environmental or anthropogenic disturbance of foraging on various life stages of selected species (sperm whale, Farmer *et al.* (2018); California sea lion, McHuron *et al.* (2018); blue whale, Pirotta *et al.* (2018a); pilot whales, Hin *et al.* (2021); gray whale, McHuron *et al.,* 2021). These models continue to add to refinement of the approaches to the population consequences of disturbance (PCOD) framework. Such models also help identify what data inputs require further investigation. Pirotta *et al.* (2018b) provides a review of the PCOD framework with details on each step of the process and approaches to applying real data or simulations to achieve each step.

New *et al.* (2020) found that closed populations of dolphins could not withstand a higher probability of disturbance, compared to open populations with no limitation on food. Two bottlenose dolphin populations in Australia were also modeled over 5 years against a number of disturbances (Reed *et al.,* 2020), and results indicated that habitat/noise disturbance had little overall impact on population abundances in either location, even in the most extreme impact scenarios modeled. By integrating different sources of data (*e.g.,* controlled exposure data, activity monitoring, telemetry tracking, and prey sampling) into a theoretical model to predict effects from sonar on a blue whale's daily energy intake, Pirotta *et al.* (2021) found that tagged blue whales' activity budgets, lunging rates, and ranging patterns caused variability in their predicted cost of disturbance. Dunlop *et al.* (2021) modeled migrating humpback whale mother-calf pairs in response to seismic surveys using both a forwards and backwards approach. While a typical forwards approach can determine if a stressor would have population-level consequences, authors demonstrated that working backwards through a PCoD model can be used to assess the ''worst case'' scenario for an interaction of a target species and stressor. This method may be useful for future management goals when appropriate data becomes available to fully support the model. Harbor porpoise movement and foraging were modeled for baseline periods and then for periods with seismic surveys as well; the models demonstrated that the seasonality of the seismic activity was an important predictor of impact (Gallagher *et al.,* 2021). Murray *et al.* (2021) conducted a cumulative effects assessment on Northern and Southern resident killer whales, which involved both a Pathways of Effects conceptual model and a Population Viability Analysis quantitative simulation model. Authors found that both populations were highly sensitive to prey abundance, and were also impacted by the interaction of low prey abundance with vessel strike, vessel noise, and polychlorinated biphenyls contaminants. However, more research is needed to validate the mechanisms of vessel disturbance and environmental containments. Czapanskiy *et al.* (2021) modeled energetic costs associated with behavioral response to mid-frequency active sonar using datasets from eleven cetaceans' feeding rates, prey characteristics, avoidance behavior, and metabolic rates. Authors found that the short-term energetic cost was influenced more by lost foraging opportunities than increased locomotor effort during avoidance. Additionally, the model found that mysticetes incurred more energetic cost that odontocetes, even during mild behavioral responses to sonar.

Stranding and Mortality

The definition for a stranding under title IV of the MMPA is that (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance (see MMPA section 410(3)). This definition is useful for considering stranding events even when they occur beyond lands and waters under the jurisdiction of the United States.

Marine mammal strandings have been linked to a variety of causes, such as illness from exposure to infectious agents, biotoxins, or parasites; starvation; unusual oceanographic or weather events; or anthropogenic causes including fishery interaction, ship strike, entrainment, entrapment, sound exposure, or combinations of these stressors sustained concurrently or in series. Historically, the cause or causes of most strandings have remained unknown (Geraci *et al.,* 1976; Eaton, 1979; Odell *et al.,* 1980; Best, 1982), but the development of trained, professional stranding response networks and improved analyses have led to a greater understanding of marine mammal stranding causes (Simeone and Moore 2017).

Numerous studies suggest that the physiology, behavior, habitat, social relationships, age, or condition of cetaceans may cause them to strand or might predispose 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 (Bernaldo de Quiros *et al.,* 2019; 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).

Historically, stranding reporting and response efforts have been inconsistent, although significant improvements have occurred over the last 25 years. Reporting forms for basic (''Level A'') information, rehabilitation disposition, and human interaction have been standardized nationally (available at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/level-data-collection-marine-mammal-stranding-events*). However, data collected beyond basic information varies by region (and may vary from case to case), and are not standardized across the United States. Logistical conditions such as weather, time, location, and decomposition state may also affect the ability of the stranding network to thoroughly examine a specimen (Carretta *et al.,* 2016b; Moore *et al.,* 2013). While the investigation of stranded animals provides insight into the types of threats marine mammal populations face, full investigations are only possible and conducted on a small fraction of the total number of strandings that occur, limiting our understanding of the causes of strandings (Carretta *et al.,* 2016a). Additionally, and due to the variability in effort and data collected, the ability to interpret long-term trends in stranded marine mammals is complicated.

Several mass strandings (strandings that involve two or more individuals of the same species, excluding a single mother-calf pair) that have occurred over the past two decades have been associated with anthropogenic activities that introduced sound into the marine environment such as naval operations and seismic surveys. An in-depth discussion of strandings is in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017).

Worldwide, there have been several efforts to identify relationships between cetacean mass stranding events and military active sonar (Cox *et al.,* 2006; Hildebrand, 2004; IWC, 2005; Taylor *et al.,* 2004). For example, based on a review of mass stranding events around the world consisting of two or more individuals of Cuvier's beaked whales, records from the International Whaling Commission (IWC) (2005) show that a quarter (9 of 41) were associated with concurrent naval patrol, explosion, maneuvers, or MFAS. D'Amico *et al.* (2009) reviewed beaked whale stranding data compiled primarily from the published literature (which provides an incomplete record of stranding events, as many are not written up for publication), along with unpublished information from some regions of the world.

Most of the stranding events reviewed by the IWC involved beaked whales. A mass stranding of Cuvier's beaked whales in the eastern Mediterranean Sea occurred in 1996 (Frantzis, 1998), and mass stranding events involving Gervais' beaked whales, Blainville's beaked whales, and Cuvier's beaked whales occurred off the coast of the Canary Islands in the late 1980s (Simmonds and Lopez-Jurado, 1991). The stranding events that occurred in the Canary Islands and Kyparissiakos Gulf in the late 1990s and the Bahamas in 2000 have been the most intensively studied mass stranding events and have been associated with naval maneuvers involving the use of tactical sonar. Other cetacean species with naval sonar implicated in stranding events include harbor porpoise (*Phocoena phocoena*) (Norman *et al.,* 2004; Wright *et al.,* 2013) and common dolphin (*Delphinus delphis*) (Jepson and Deaville 2009). 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 lbs (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 Oceanside, California (3 days later and approximately 68 km north of the detonation), 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. Despite this being a rare occurrence, NMFS and the Navy reviewed training requirements, safety procedures, and possible mitigation measures and implemented changes to reduce the potential for this to occur in the future—specifically increasing the size of the exclusion zone to better account for the time-delay fuse and the distance that marine mammals might travel during the time delay. Discussions of procedures associated with in-air explosives at or above the water surface during training are presented in the Proposed Mitigation Measures 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 the 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 Active Sonar

Over the past 21 years, there have been five stranding events coincident with naval MF active 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) (Cox *et al.,* 2006; Fernandez, 2006; U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017). These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with close linkages to mid-frequency active sonar activity. In these circumstances, exposure to non-impulsive acoustic energy was considered a potential indirect cause of death of the marine mammals (Cox *et al.,* 2006). Only one of these stranding events, the Bahamas (2000), was associated with exercises conducted by the U.S. Navy. 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 Hanalei Bay stranding. A number of other stranding events coincident with the operation of MFAS, including the death of beaked whales or other species (minke whales, dwarf sperm whales, pilot whales), have been reported; however, the majority have not been investigated to the degree necessary to determine the cause of the stranding. 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 (Southall *et al.,* 2013). 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 the proposed mitigation measures intended to more broadly minimize impacts to marine mammals, the Navy would abide by the Notification and Reporting Plan, which sets out notification, reporting, and other requirements when dead, injured, or stranded marine mammals are detected in certain circumstances.

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 significant apparent abnormalities or wounds were found, however examination of photos of the animals, taken soon after their death, revealed that the eyes of at least four of the individuals were bleeding (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 was 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 historical records), 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-hour 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, Portugal (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 a fisherman but did not come ashore (Woods Hole Oceanographic Institution, 2005). Joint NATO amphibious training peacekeeping exercises involving participants from 17 countries and 80 warships, took place in Portugal 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 nmi (65 km) and at least 10 nmi (19 km) in length, or in an embayment. Exercises involving multiple ships employing MFAS near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

Canary Islands, Spain (2002)

The southeastern area within the Canary Islands is well known for aggregations of beaked whales due to its ocean depths of greater than 547 fathoms (1,000 m) within a few hundred meters of the coastline (Fernandez *et al.,* 2005). On September 24, 2002, 14 beaked whales were found stranded on Fuerteventura and Lanzarote Islands in the Canary Islands (International Council for Exploration of the Sea, 2005a). Seven whales died, while the remaining seven live whales were returned to deeper waters (Fernandez *et al.,* 2005). Four beaked whales were found stranded dead over the next 3 days either on the coast or floating offshore. These strandings occurred within close 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, 6 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 the Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson *et al.,* 2003; Fernández *et al.,* 2005).

Hanalei Bay, Hawaii (2004)

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

Only one animal, a calf, was known to have died following this event. The animal was noted alive and alone in the Bay on the afternoon of July 4, 2004, and was found dead in the Bay the morning of July 5, 2004. A full necropsy, magnetic resonance imaging, and computerized tomography examination were performed on the calf to determine the manner and cause of death. The combination of imaging, necropsy, and histological analyses found no evidence of infectious, internal traumatic, congenital, or toxic factors. 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 United States. The weather conditions appeared to be normal for that time of year with no fronts or other significant features noted. There was no evidence of unusual distribution, occurrence of predator or prey species, or unusual harmful algal blooms, although Mobley *et al.* (2007) suggested that the full moon cycle that occurred at that time may have influenced a run of squid into the Bay. Weather patterns and bathymetry that have been associated with mass strandings elsewhere were not found to occur in this instance.

The Hanalei event was spatially and temporally correlated with RIMPAC. Official sonar training and tracking exercises in the Pacific Missile Range Facility (PMRF) warning area did not commence until approximately 8 a.m. on July 3 and were thus ruled out as a possible trigger for the initial movement into the Bay. However, six naval surface vessels transiting to the operational area on July 2 intermittently transmitted active sonar (for approximately 9 hours total from 1:15 p.m. to 12:30 a.m.) as they approached from the south. The potential for these transmissions to have triggered the whales' movement into Hanalei Bay was investigated. Analyses with the information available indicated that animals to the south and east of Kaua'i could have detected active sonar transmissions on July 2, and reached Hanalei Bay on or before 7 a.m. on July 3. 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 considers 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, 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 Mojácar (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 Mojácar 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 nmi (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).

Behaviorally Mediated Responses to MFAS That May Lead to Stranding

Although the confluence of Navy MFAS with the other contributory factors noted in the 2001 NMFS/Navy joint 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 well 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). In a review of the previously published data on the potential impacts of sonar on beaked whales, Bernaldo de Quirós *et al.* (2019) suggested that the effect of mid-frequency active sonar on beaked whales varies among individuals or populations, and that predisposing conditions such as previous exposure to sonar and individual health risk factors may contribute to individual outcomes (such as decompression sickness).

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.* (2001b) 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 km) 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 (see also 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 Cuvier's beaked whale), 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 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 at which lung collapse occurs. 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 could 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). Please see the *Flight Response* section of this proposed rule for additional discussion.

Despite the many theories involving bubble formation (both as a direct cause of injury, see *Acoustically-Induced Bubble Formation Due to Sonars and Other Pressure-related Injury* section and an indirect cause of stranding), 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 Study Area

Stranded marine mammals are reported along the entire western coast of the United States each year. Marine mammals strand due to natural or anthropogenic causes; the majority of reported type of occurrences in marine mammal strandings in the Pacific include fisheries interactions, entanglement, vessel strike, and predation (Carretta *et al.,* 2019a; Carretta *et al.,* 2019b; Carretta *et al.,* 2017a; Helker *et al.,* 2019; Helker *et al.,* 2017; NOAA, 2018, 2019). Stranding events that are associated with active UMEs in Alaska (inclusive of the GOA Study Area) were previously discussed in the Description of Marine Mammals and Their Habitat in the Area of the Specified Activities section.

In 2020, there were 65 confirmed strandings reported in the Gulf of Alaska (Savage, 2021). Of these strandings, 43 were cetaceans; 20 of the stranded cetaceans were gray whales, which as discussed in the Description of Marine Mammals and Their Habitat in the Area of the Specified Activities section of this proposed rule, are affected by a UME. Of the 2020 confirmed reports involving human interaction, most reports indicated an entanglement. Naval sonar has been identified as a contributing factor in a small number of strandings as discussed above; however, none of these have occurred in the GOA Study Area.

Potential Effects of Vessel Strike

Vessel collisions with marine mammals, also referred to as vessel strikes or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). 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. Superficial strikes may not kill or result in the death of the animal. Lethal interactions are typically associated with large whales, which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, as a general matter they may also be susceptible to strike.

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 one recent case, an Australian naval vessel struck both a mother fin whale and calf off the coast of California. In addition, some baleen whales 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. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

Some researchers have suggested the relative risk of a vessel strike can be assessed as a function of animal density and the magnitude of vessel traffic (*e.g.,* Fonnesbeck *et al.,* 2008; Vanderlaan *et al.,* 2008). Differences among vessel types also influence the probability of a vessel strike. The ability of any ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and ability and number of personnel observing, as well as the behavior of the animal.

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 occurs and, if so, whether it results in injury, serious injury, or mortality (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Jensen and Silber, 2003; Pace and Silber, 2005; Vanderlaan and Taggart, 2007; Conn and Silber 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011). For large vessels, speed and angle of approach can influence the severity of a strike. 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 kn.

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 58 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 kn. The majority (79 percent) of these strikes occurred at speeds of 13 kn or greater. The average speed that resulted in serious injury or death was 18.6 kn. 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 kn, and exceeded 90 percent at 17 kn. 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).

In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 kn.

Large whales also do not have to be at the water's surface to be struck. Silber *et al.* (2010) found when a whale is below the surface (about one to two times the vessel draft), there is likely to be a pronounced propeller suction effect. This suction effect may draw the whale into the hull of the ship, increasing the probability of propeller strikes.

The Jensen and Silber (2003) report notes that the Large Whale Ship Strike Database represents a minimum number of collisions, because the vast majority probably goes undetected or unreported. In contrast, Navy personnel are more likely to detect any strike that does occur because of the required personnel training and Lookouts (as described in the Proposed Mitigation Measures section), and they are required to report all ship strikes involving marine mammals.

There are some key differences between the operation of military and non-military vessels, which make the likelihood of a military vessel striking a whale lower than some other vessels (*e.g.,* commercial merchant vessels), although as noted above strikes by naval vessels can occur. Key differences include:

- many military ships have their bridges positioned closer to the bow, offering better visibility ahead of the ship (compared to a commercial merchant vessel);
- there are often aircraft associated with the training activity (which can serve as Lookouts), which can more readily detect cetaceans in the vicinity of a vessel or ahead of a vessel's present course before crew on the vessel would be able to detect them;
- military ships are generally more maneuverable than commercial merchant vessels, and if cetaceans are spotted in the path of the ship, could be capable of changing course more quickly;
- the crew size on military vessels is generally larger than merchant ships, allowing for stationing more trained Lookouts on the bridge. At all times when vessels are underway, trained Lookouts and bridge navigation teams are used to detect objects on the surface of the water ahead of the ship, including cetaceans. Additional Lookouts, beyond those already stationed on the bridge and on navigation teams, are positioned as Lookouts during some training events; and
- when submerged, submarines are generally slow moving (to avoid detection) and therefore marine mammals at depth with a submarine are likely able to avoid collision with the submarine. When a submarine is transiting on the surface, there are Lookouts serving the same function as they do on surface ships.

In the GOA Study Area, NMFS and the Navy have no documented vessel strikes of marine mammals by the Navy. Therefore, NMFS has not used the quantitative approach to assess the likelihood of vessel strikes used in the Phase III incidental take rulemakings for Navy activities in the Atlantic Fleet Training and Testing (AFTT) and Hawaii-Southern California Training and Testing (HSTT) Study Areas, which starts with the number of Navy strikes that have occurred in the study area in question. But based on this lack of strikes and other factors described below, which the Navy presented and NMFS agrees are appropriate factors to consider in assessing the likelihood of ship strike, the Navy does not anticipate vessel strikes and has not requested authorization to take marine mammals by serious injury or mortality within the GOA Study Area during training activities. Based on consideration of all pertinent information, including, as appropriate, information on ship strikes in other Navy study areas, NMFS agrees with the Navy's conclusion based on the analysis and other factors described below.

Within Alaska waters, there were 28 reported marine mammal vessel strikes between 2013 and 2017 (none of which were from U.S. Navy vessels) (Delean *et al.,* 2020), which is a primary consideration in the evaluation of the likelihood that a strike by U.S. Navy vessels would occur in the GOA Study Area in the next 7 years. Though not in the same region, and noting the larger scale and differences in types of activities that occur there, NMFS also considered the incidents of two accidental ship strikes of large whales by U.S. Navy vessels in the HSTT Study Area that occurred in June 2021 and July 2021 (the first U.S. Navy ship strikes in the HSTT Study Area since 2009). The two ship strikes were of large whales, but in both cases, the whale's species could not be determined. Appropriately, as indicated in the Navy's 2022 application (87 FR 33113; June 1, 2022) to revise the 2020 HSTT regulations (50 CFR part 218, subpart H) and LOAs, and as has been the practice in NMFS analyses for all major Navy training and testing rules, those strikes would be quantitatively incorporated into the prediction of future strikes in that region. However, due to differences across regions, both in the density and occurrence of marine mammals, the levels and types of activities, and other environmental factors—all of which contribute to differences in the historical strikes in a given region—strikes that occur in the HSTT Study Area are not quantitatively considered in strike predictions for the GOA Study Area.

More broadly regarding the likelihood of strikes from U.S. Navy vessels, large Navy vessels (greater than 18 m in length) within the offshore areas of range complexes operate differently from commercial vessels in ways that still likely reduce potential whale collisions. Surface ships operated by or for the Navy have multiple personnel assigned to stand watch at all times when a ship or surfaced submarine is moving through the water (underway). A primary duty of personnel standing watch on surface ships is to detect and report all objects and disturbances sighted in the water that may indicate a threat to the vessel and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per vessel safety requirements, personnel standing watch also report any marine mammals sighted in the path of the vessel as a standard collision avoidance procedure. All vessels proceed at a safe speed so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

Between 2007 and 2009, the Navy developed and distributed additional training, mitigation, and reporting tools to Navy operators to improve marine mammal protection and to ensure compliance with LOA requirements. In 2009, the Navy implemented Marine Species Awareness Training designed to improve effectiveness of visual observation for marine resources, including marine mammals. Additionally, for over a decade, the Navy has implemented the Protective Measures Assessment Protocol software tool, which provides operators with notification of the required mitigation and a visual display of the planned training or testing activity location overlaid with relevant environmental data.

Furthermore, specific to the Navy's proposed activities in the GOA Study Area, the training activities would occur over a maximum of 21 days annually over a large area within the Gulf of Alaska, in comparison to Navy activities that occur 365 days-per-year in other Study Areas. The GOA Study Area activities would include one Carrier Strike Group, which the Navy indicates would include up to six surface vessels (though in some cases there could be more vessels, and in some cases there could be fewer). Therefore, the Navy's activities in the GOA Study Area would include an estimated 126 at-sea days (6 vessels × 21 days) annually. This level of potential Navy vessel activity is far lower than vessel activity in other Study Areas. The estimated number of at-sea days for Navy training activities in the GOA Study Area is approximately 1/4th of that associated with Navy training and testing in the Mariana Islands Training and Testing (MITT) Study Area (where vessel strike is also not anticipated and has not occurred) over the same time period, and approximately 1/36th of that associated with Navy training and testing in the Hawaii-Southern California Training and Testing (HSTT) Study Area (where limited vessel strike is authorized) over the same time period. In addition to vessel strikes of large whales being unlikely to occur for the reasons explained, the Navy would implement certain additional mitigation measures that would reduce the chance of a vessel strike even further. See the Proposed Mitigation Measures section for more details.

Based on all of these considerations, NMFS has preliminarily determined that the Navy's decision not to request incidental take authorization for vessel strike of large whales is reasonable and supported by multiple factors, including the lack of ship strike reports in recent (2013–2017) stranding records for Alaska waters (including no strikes by Navy vessels in the GOA Study Area; Delean *et al.,* 2020), the relatively small numbers of Navy vessels across a large expanse of offshore waters in the GOA Study Area, the relatively short activity period in which Navy vessels would operate (maximum of 21 days per year), and the procedural mitigation measures that would be in place to further minimize the potential for vessel strike.

In addition to the reasons listed above that make it unlikely that the Navy would hit a large whale (more maneuverable ships, larger crew, etc.), the following are additional reasons that vessel strike of dolphins, small whales, and pinnipeds is very unlikely. Dating back more than 20 years and for as long as it has kept records, the Navy has no records of any small whales or pinnipeds being struck by a vessel as a result of Navy activities. Over the same time period, NMFS and the Navy have only one record of a dolphin being struck by a vessel as a result of Navy activities. The dolphin was accidentally struck by a Navy small boat in fall 2021 in Saint Andrew's Pass, Florida. The smaller size and maneuverability of dolphins, small whales, and pinnipeds generally make such strikes very unlikely. Other than this one reported strike of a dolphin in 2021, NMFS has never received any reports from other LOA or Incidental Harassment Authorization holders indicating that these species have been struck by vessels. In addition, worldwide ship strike records show little evidence of strikes of these groups from the shipping sector and larger vessels, and the majority of the Navy's activities involving faster-moving vessels (that could be considered more likely to hit a marine mammal) are located in offshore areas where smaller delphinid densities are lower. The majority of the GOA Study Area is located offshore of the continental slope. While the Navy's specified activities in the GOA Study Area do involve the use of small boats also, use of small boats would occur on no more than 21 days per year, the length of the Navy's proposed training exercise. Based on this information, NMFS concurs with the Navy's assessment that vessel strike is not likely to occur for either large whales or smaller marine mammals.

Marine Mammal Habitat

The Navy's proposed training activities could potentially affect marine mammal habitat through the introduction of impacts to the prey species of marine mammals, acoustic habitat (sound in the water column), water quality, and biologically important habitat for marine mammals. Each of these potential effects was considered in the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS, and based on the information below and the supporting information included in the 2020 GOA DSEIS/OEIS, NMFS has preliminarily determined that the proposed training activities would not have adverse or long-term impacts on marine mammal habitat that would be expected to affect the reproduction or survival of any marine mammals.

Effects to Prey

Sound may affect marine mammals through impacts on the abundance, behavior, or distribution of prey species (*e.g.,* crustaceans, cephalopods, fish, zooplankton). Marine mammal prey varies by species, season, and location and, for some species, is not well documented. Here, we describe studies regarding the effects of noise on known marine mammal prey.

Fish utilize the soundscape and components of sound in their environment to perform important functions such as foraging, predator avoidance, mating, and spawning (*e.g.,* Zelick *et al.,* 1999; Fay, 2009). The most likely effects on fishes exposed to loud, intermittent, low-frequency sounds are behavioral responses (*i.e.,* flight or avoidance). Short duration, sharp sounds (such as pile driving or air guns) can cause overt or subtle changes in fish behavior and local distribution. The reaction of fish to acoustic sources depends on the physiological state of the fish, past exposures, motivation (*e.g.,* feeding, spawning, migration), and other environmental factors. Key impacts to fishes may include behavioral responses, hearing damage, barotrauma (pressure-related injuries), and mortality.

Fishes, like other vertebrates, have a variety of different sensory systems to glean information from the ocean around them (Astrup and Mohl, 1993; Astrup, 1999; Braun and Grande, 2008; Carroll *et al.,* 2017; Hawkins and Johnstone, 1978; Ladich and Popper, 2004; Ladich and Schulz-Mirbach, 2016; Mann, 2016; Nedwell *et al.,* 2004; Popper *et al.,* 2003; Popper *et al.,* 2005). Depending on their hearing anatomy and peripheral sensory structures, which vary among species, fishes hear sounds using pressure and particle motion sensitivity capabilities and detect the motion of surrounding water (Fay *et al.,* 2008) (terrestrial vertebrates generally only detect pressure). Most marine fishes primarily detect particle motion using the inner ear and lateral line system, while some fishes possess additional morphological adaptations or specializations that can enhance their sensitivity to sound pressure, such as a gas-filled swim bladder (Braun and Grande, 2008; Popper and Fay, 2011).

Hearing capabilities vary considerably between different fish species with data only available for just over 100 species out of the 34,000 marine and freshwater fish species (Eschmeyer and Fong, 2016). In order to better understand acoustic impacts on fishes, fish hearing groups are defined by species that possess a similar continuum of anatomical features which result in varying degrees of hearing sensitivity (Popper and Hastings, 2009a). There are four hearing groups defined for all fish species (modified from Popper *et al.,* 2014) within this analysis and they include: fishes without a swim bladder (*e.g.,* flatfish, sharks, rays, *etc.*); fishes with a swim bladder not involved in hearing (*e.g.,* salmon, cod, pollock, *etc.*); fishes with a swim bladder involved in hearing (*e.g.,* sardines, anchovy, herring, *etc.*); and fishes with a swim bladder involved in hearing and high-frequency hearing (*e.g.,* shad and menhaden).

In terms of behavioral responses, Juanes *et al.* (2017) discuss the potential for negative impacts from anthropogenic soundscapes on fish, but the author's focus was on broader based sounds such as ship and boat noise sources. There are no detonations of explosives occurring underwater in the specified activity for this rulemaking, and occasional behavioral reactions to intermittent explosions occurring in-air at or above the water surface are unlikely to cause long-term consequences for individual fish or populations. Fish that experience hearing loss as a result of exposure to explosions may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. However, PTS has not been known to occur in fishes, and 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 (Popper *et al.,* 2014; Popper *et al.,* 2005; Smith *et al.,* 2006). It is not known if damage to auditory nerve fibers could occur and, if so, whether fibers would recover during this process. It is also possible for fish to be injured or killed by an explosion in the immediate vicinity of the surface from dropped or fired ordnance. Physical effects from pressure waves generated by in-air detonations at or above the water surface could potentially affect fish within proximity of training activities. The shock wave from an explosion occurring at or above the water surface may be lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin and Hempen, 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors, including fish size, body shape, orientation, and species (Keevin and Hempen, 1997; Wright, 1982). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Edds-Walton and Finneran, 2006; O'Keeffe, 1984; O'Keeffe and Young, 1984; Wiley *et al.,* 1981; Yelverton *et al.,* 1975). Species with gas-filled organs have a higher potential for mortality than those without them (Gaspin, 1975; Gaspin *et al.,* 1976; Goertner *et al.,* 1994).

Nonetheless, Navy activities involving in-air explosions at or above the water surface are dispersed in space and time; therefore, repeated exposure of individual fishes is unlikely. Mortality and injury effects to fishes from explosives would be localized around the area of a given explosion at or above the water surface, but only if individual fish and the explosive (and immediate pressure field) were co-located at the same time. Fishes deeper in the water column or on the bottom would not be affected by water surface explosions. Repeated exposure of individual fish to sound and energy from Navy events involving in-air detonations at or above the water surface is not likely given fish movement patterns, especially schooling prey species. Most acoustic effects, if any, are expected to be short term and localized. Long-term consequences for fish populations, including key prey species within the GOA Study Area, would not be expected.

Vessels and surface targets do not normally collide with adult fish, most of which can detect and avoid them. Exposure of fishes to vessel strike stressors is limited to those fish groups that are large, slow moving, and may occur near the surface, such as basking sharks, which are not marine mammal prey species. Vessel strikes would not pose a risk to most of the other marine fish groups, because many fish can detect and avoid vessel movements, making strikes extremely unlikely and allowing the fish to return to their normal behavior after the ship or device passes. As a vessel approaches a fish, it could have a detectable behavioral or physiological response (*e.g.,* swimming away and increased heart rate) as the passing vessel displaces it. However, such reactions are not expected to have effects on the survival, growth, recruitment, or reproduction of these marine fish groups at the population level.

In addition to fish, prey sources such as marine invertebrates could potentially be impacted by sound stressors as a result of the planned activities. Data on response of invertebrates such as squid has been documented (de Soto, 2016; Sole *et al.,* 2017). Sole *et al.* (2017) reported physiological injuries to cuttlefish in cages placed at sea when exposed during a controlled exposure experiment to low-frequency sources (315 Hz, 139–142 dB re 1 μPa^2 and 400 Hz, 139–141 dB re 1 μPa^2). Fewtrell and McCauley (2012) reported squids maintained in cages displayed startle responses and behavioral changes when exposed to seismic air gun sonar (136–162 re 1 μPa^2-s). However, the sources Sole *et al.* (2017) and Fewtrell and

McCauley (2012) used are not similar and are much lower frequency than typical Navy sources or those included in the Specified Activity within the GOA Study Area. Nor do the studies address the issue of individual displacement outside of a zone of impact when exposed to sound. Squids, like most fish species, are likely more sensitive to low-frequency sounds, and may not perceive mid- and high-frequency sonars such as Navy sonars. As with fish, cumulatively individual and population-level impacts from exposure to Navy sonar and explosives for squid are not anticipated, and explosive impacts would be short term, localized, and likely to be inconsequential to invertebrate populations.

Explosions could kill or injure other nearby marine invertebrates. Vessels also have the potential to impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms (Bishop, 2008). The propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls can potentially disturb marine invertebrates in the water column and is a likely cause of zooplankton mortality (Bickel *et al.,* 2011). The localized and short-term exposure to explosions or vessels could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates. However, mortality or long-term consequences for a few animals is unlikely to have measurable effects on overall stocks or populations. Long-term consequences to marine invertebrate populations would not be expected as a result of exposure to sounds or vessels in the GOA Study Area.

Military expended materials resulting from training could potentially result in minor long term changes to benthic habitat. Military expended materials may be colonized over time by benthic organisms that prefer hard substrate and would provide structure that could attract some species of fish or invertebrates. Overall, the combined impacts of sound exposure, explosions, vessel strikes, and military expended materials resulting from the specified activity would not be expected to have measurable effects on populations of marine mammal prey species and marine mammal habitat.

Acoustic Habitat

Acoustic habitat is the soundscape which encompasses all of the sound present in a particular location and time, as a whole when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of air gun arrays) or for Navy training purposes (as in the use of sonar and other acoustic sources). Anthropogenic noise varies widely in its frequency, content, duration, and loudness, and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please also see the previous discussion on ''Masking''), which may range from local effects for brief periods of time to chronic effects over large areas and for longer durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). For more detail on these concepts see, *e.g.,* Barber *et al.,* 2009; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014, Hatch *et al.,* 2016; Duarte *et al.,* 2021).

The term ''listening area'' refers to the region of ocean over which sources of sound can be detected by an animal at the center of the space. Loss of communication space concerns the area over which a specific animal signal (used to communicate with conspecifics in biologically important contexts such as foraging or mating) can be heard, in noisier relative to quieter conditions (Clark *et al.,* 2009). Lost listening area concerns the more generalized contraction of the range over which animals would be able to detect a variety of signals of biological importance, including eavesdropping on predators and prey (Barber *et al.,* 2009). Such metrics do not, in and of themselves, document fitness consequences for the marine animals that live in chronically noisy environments. Long-term population-level consequences mediated through changes in the ultimate survival and reproductive success of individuals are difficult to study, and particularly so underwater. However, it is increasingly well documented that aquatic species rely on qualities of natural acoustic habitats, with researchers quantifying reduced detection of important ecological cues (*e.g.,* Francis and Barber, 2013; Slabbekoorn *et al.,* 2010) as well as survivorship consequences in several species (*e.g.,* Simpson *et al.,* 2014; Nedelec *et al.,* 2015).

The sounds produced during Navy training activities can be widely dispersed or concentrated in small areas for varying periods. Sound produced from training activities in the GOA Study Area is temporary and limited to a 21 consecutive day period from April to October, unlike other Navy Study Areas where training occurs year-round. Any anthropogenic noise attributed to training activities in the GOA Study Area would be temporary and the affected area would be expected to immediately return to the original state when these activities cease.

Water Quality

The 2011 GOA EIS/OEIS analyzed the potential effects on water quality from explosives, explosive byproducts, and military expended materials including their associated component metals and chemicals. This analysis remains accurate and complete, and is incorporated by reference in the 2016 GOA SEIS/OEIS and 2020 GOA DSEIS/OEIS. NMFS has reviewed this analysis and concurs that it reflects the best available science. High order explosions consume most of the explosive material, creating typical combustion products. For example, in the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents and the remainder is rapidly diluted below levels that would be expected to affect marine mammals. Explosion byproducts associated with high order detonations present no secondary stressors to marine mammals through sediment or water. However, low order detonations and unexploded ordnance present a potential for exposure, but only in the immediate vicinity of the ordnance. Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Carniel *et al.,* 2019; Rosen and Lotufo, 2010) and any remnant undetonated components from explosives such as TNT, royal demolition explosive, and high melting explosive experience rapid biological and photochemical degradation in marine systems (Carniel *et al.,* 2019; Cruz-Uribe *et al.,* 2007; Juhasz and Naidu, 2007; Pavlostathis and Jackson, 2002; Singh *et al.,* 2009; Walker *et al.,* 2006).

The findings from multiple studies indicate the relatively low solubility of most explosives and their degradation products, metals, and chemicals meaning that concentrations of these contaminants in the marine environment, including those associated with either high-order or low-order detonations, are relatively low and readily diluted. A series of studies of a World War II dump site off Hawaii have demonstrated that only minimal concentrations of degradation products were detected in the adjacent sediments and that there was no detectable uptake in sampled organisms living on or in proximity to the site (Briggs *et al.,* 2016; Carniel *et al.,* 2019; Edwards *et al.,* 2016; Hawaii Undersea Military Munitions Assessment, 2010; Kelley *et al.,* 2016; Koide *et al.,* 2016). In the GOA Study Area, the concentration of unexploded ordnance, explosion byproducts, metals, and other chemicals would never exceed that of a World War II dump site. As another example, the Canadian Forces Maritime Experimental and Test Ranges near Nanoose, British Columbia, began operating in 1965 conducting test events for both U.S. and Canadian forces, which included some of the same activities proposed for the GOA Study Area. Environmental analyses of the impacts from military expended materials at Nanoose were documented in 1996 and 2005. The analyses concluded the Navy test activities ''. . . had limited and perhaps negligible effects on the natural environment'' (Environmental Science Advisory Committee, 2005). Based on these and other similar applicable findings from multiple Navy ranges, and based on the analysis in Section 3.3 (Water Resources) of the 2011 GOA Final SEIS/OEIS (incorporated by reference in the 2020 GOA Draft EIS/OEIS), indirect impacts on marine mammals from the training activities in the GOA Study Area would be negligible and would have no long-term effect on habitat.

Equipment used by the Navy within the GOA Study Area, including ships and other marine vessels, aircraft, and other equipment, are also potential sources of by-products. All equipment is properly maintained in accordance with applicable Navy and legal requirements. All such operating equipment meets Federal water quality standards, where applicable.

Estimated Take of Marine Mammals

This section indicates the number of takes that NMFS is proposing to authorize, which are based on the maximum amount of take that NMFS anticipates is reasonably likely to occur. NMFS coordinated closely with the Navy in the development of their incidental take application, and preliminarily agrees that the methods the Navy has put forth described herein to estimate take (including the model, thresholds, and density estimates), and the resulting numbers are based on the best available science and appropriate for authorization.

Takes would be in the form of harassment only. For a military readiness activity, 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).

Proposed authorized takes would primarily be in the form of Level B harassment, as use of the acoustic and explosive sources (*i.e.,* sonar and explosives) is most likely to result in the disruption of natural behavioral patterns to a point where they are abandoned or significantly altered (as defined specifically at the beginning of this section, but referred to generally as behavioral disturbance) or TTS for marine mammals. There is also the potential for Level A harassment, in the form of auditory injury that results from exposure to the sound sources utilized in training activities.

Generally speaking, for acoustic impacts NMFS estimates the amount and type of harassment by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals would experience behavioral disturbance or incur some degree of temporary or permanent hearing impairment; (2) the area or volume of water that would be ensonified above these levels in a day or event; (3) the density or occurrence of marine mammals within these ensonified areas; and (4) the number of days of activities or events.

Acoustic Thresholds

Using the best available science, NMFS, in coordination with the Navy, has established acoustic thresholds that identify the most appropriate received level of underwater sound above which marine mammals exposed to these sound sources could be reasonably expected to experience a disruption in behavior patterns to a point where they are abandoned or significantly altered (equated to onset of Level B harassment), or to incur TTS onset (equated to Level B harassment) or PTS onset (equated to Level A harassment). Thresholds have also been developed to identify the pressure and impulse levels above which animals may incur non-auditory injury or mortality from exposure to explosive detonations (although no non-auditory injury from explosives is anticipated as part of this rulemaking).

Despite the rapidly evolving science, there are still challenges in quantifying expected behavioral responses that qualify as take by Level B harassment, especially where the goal is to use one or two predictable indicators (*e.g.,* received level and distance) to predict responses that are also driven by additional factors that cannot be easily incorporated into the thresholds (*e.g.,* context). So, while the thresholds that identify Level B harassment by behavioral disturbance (referred to as ''behavioral harassment thresholds'') have been refined to better consider the best available science (*e.g.,* incorporating both received level and distance), they also still have some built-in conservative factors to address the challenge noted. For example, while duration of observed responses in the data are now considered in the thresholds, some of the responses that are informing take thresholds are of a very short duration, such that it is possible some of these responses might not always rise to the level of disrupting behavior patterns to a point where they are abandoned or significantly altered. We describe the application of this behavioral harassment threshold as identifying the maximum number of instances in which marine mammals could be reasonably expected to experience a disruption in behavior patterns to a point where they are abandoned or significantly altered. In summary, we believe these behavioral harassment thresholds are the most appropriate method for predicting Level B harassment by behavioral disturbance given the best available science and the associated uncertainty.

Hearing Impairment (TTS/PTS) and Non-Auditory Tissue Damage and Mortality

NMFS' Acoustic Technical Guidance (NMFS, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). The Acoustic Technical Guidance also identifies criteria to predict TTS, which is not considered injury and falls into the Level B harassment category. The Navy's planned activity includes the use of non-impulsive (sonar) and impulsive (explosives) sources.

These thresholds (Table 5 and Table 6) were developed by compiling and synthesizing the best available science and soliciting input multiple times from both the public and peer reviewers. The references, analysis, and methodology used in the development of the thresholds are described in Acoustic Technical Guidance, which may be accessed at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

TABLE 5—ACOUSTIC THRESHOLDS IDENTIFYING THE ONSET OF TTS AND PTS FOR NON-IMPULSIVE SOUND SOURCES BY FUNCTIONAL HEARING GROUPS

Functional hearing group	Non-impulsive	
	TTS threshold SEL (weighted)	PTS threshold SEL (weighted)
Low-Frequency Cetaceans	179	199
Mid-Frequency Cetaceans	178	198
High-Frequency Cetaceans	153	173
Phocid Pinnipeds (Underwater)	181	201
Otarid Pinnipeds (Underwater)	199	219

Note: SEL thresholds in dB re: 1 μPa^2-s accumulated over a 24-hr period.

Based on the best available science, the Navy (in coordination with NMFS) used the acoustic and pressure thresholds indicated in Table 6 to predict the onset of TTS, PTS, non-auditory tissue damage, and mortality for explosives (impulsive) and other impulsive sound sources.

TABLE 6—THRESHOLDS FOR TTS, PTS, NON-AUDITORY TISSUE DAMAGE, AND MORTALITY THRESHOLDS FOR MARINE MAMMALS FOR EXPLOSIVES

Functional hearing group	Species	Weighted onset TTS [1]	Weighted onset PTS	Slight GI tract injury	Slight lung injury	Mortality
Low-frequency cetaceans	All mysticetes	168 dB SEL or 213 dB Peak SPL.	183 dB SEL or 219 dB Peak SPL.	243 dB Peak SPL	Equation 1.	Equation 2.
Mid-frequency cetaceans	Most delphinids, medium and large toothed whales.	170 dB SEL or 224 dB Peak SPL.	185 dB SEL or 230 dB Peak SPL.	243 dB Peak SPL.		
High-frequency cetaceans	Porpoises and *Kogia spp*.	140 dB SEL or 196 dB Peak SPL.	155 dB SEL or 202 dB Peak SPL.	243 dB Peak SPL.		
Phocidae	Harbor seal, Hawaiian monk seal, Northern elephant seal.	170 dB SEL or 212 dB Peak SPL.	185 dB SEL or 218 dB Peak SPL.	243 dB Peak SPL.		
Otariidae	California sea lion, Guadalupe fur seal, Northern fur seal.	188 dB SEL or 226 dB Peak SPL.	203 dB SEL or 232 dB Peak SPL.	243 dB Peak SPL.		

Notes:
Equation 1: $47.5M^{1/3} (1+[D_{Rm}/10.1])^{1/6}$ Pa-sec.
Equation 2: $103M^{1/3} (1+[D_{Rm}/10.1])^{1/6}$ Pa-sec.
M = mass of the animals in kg.
D_{Rm} = depth of the receiver (animal) in meters.
SPL = sound pressure level.
Weighted SEL thresholds in dB re: 1 μPa^2-s accumulated over a 24-h period.
[1] Peak thresholds are unweighted.

The criteria used to assess the onset of TTS and PTS due to exposure to sonars (non-impulsive, see Table 5 above) are discussed further in the Navy's rulemaking/LOA application (see Hearing Loss from Sonar and Other Transducers in Chapter 6, Section 6.4.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers). Refer to the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived, and to Section 3.8.3.1.1.2 of the 2020 GOA DSEIS/OEIS for a review of TTS research published following development of the criteria and thresholds applied in the Navy's analysis and in NMFS' Acoustic Technical Guidance. Further, since publication of the 2020 GOA DSEIS/OEIS, several additional studies associated with TTS in harbor porpoises and seals have been published (*e.g.,* Kastelein *et al.,* 2020d; Kastelein *et al.,* 2021a and 2021b; Sills *et al.,* 2020). NMFS is aware of these recent papers and is currently working with the Navy to update NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Version 2.0 (Acoustic Technical Guidance; NMFS 2018) to reflect relevant papers that have been published since the 2018 update on our 3–5 year update schedule in the Acoustic Technical Guidance. First, we note that the recent peer-reviewed updated marine mammal noise exposure criteria by Southall *et al.* (2019a) provide identical PTS and TTS thresholds and weighting functions to those provided in NMFS' Acoustic Technical Guidance.

NMFS will continue to review and evaluate new relevant data as it becomes available and consider the impacts of those studies on the Acoustic Technical Guidance to determine what revisions/updates may be appropriate. However, any such revisions must undergo peer and public review before being adopted, as described in the Acoustic Guidance methodology. While some of the relevant data may potentially suggest changes to TTS/PTS thresholds for some species, any such changes would not be expected to change the predicted take estimates in a manner that would change the necessary determinations supporting the issuance of these regulations, and the data and values used in this rule reflect the best available science.

Non-auditory injury (*i.e.,* other than PTS) and mortality from sonar and other transducers is so unlikely as to be discountable under normal conditions for the reasons explained under the Potential Effects of Specified Activities on Marine Mammals and Their Habitat section—*Acoustically-Induced Bubble Formation Due to Sonars and Other Pressure-related Impacts* and is therefore not considered further in this analysis.

Level B Harassment by Behavioral Disturbance

Though significantly driven by received level, the onset of Level B harassment by behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.,* frequency, predictability, duty cycle), the environment (*e.g.,* bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Ellison *et al.,* 2011; Southall *et al.,* 2007). Based on what the available science indicates and the practical need to use thresholds based on a factor, or factors, that are both predictable and measurable for most activities, NMFS uses generalized acoustic thresholds based primarily on received level (and distance in some cases) to estimate the onset of Level B harassment by behavioral disturbance.

Sonar

As noted above, the Navy coordinated with NMFS to develop, and propose for use in this rule, thresholds specific to their military readiness activities utilizing active sonar that identify at what received level and distance Level B harassment by behavioral disturbance would be expected to result. These thresholds are referred to as ''behavioral harassment thresholds'' throughout the rest of the rule. These behavioral harassment thresholds consist of behavioral response functions (BRFs) and associated cutoff distances, and are also referred to, together, as ''the criteria.'' These criteria are used to estimate the number of animals that may exhibit a behavioral response that rises to the level of a take when exposed to sonar and other transducers. The way the criteria were derived is discussed in detail in the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c). Developing these behavioral harassment criteria involved multiple steps. All peer-reviewed published behavioral response studies conducted both in the field and on captive animals were examined in order to understand the breadth of behavioral responses of marine mammals to tactical sonar and other transducers. NMFS has carefully reviewed the Navy's criteria, *i.e.,* BRFs and cutoff distances for the species, and agrees that it is the best available science and is the appropriate method to use at this time for determining impacts to marine mammals from military sonar and other transducers and for calculating take and to support the determinations made in this proposed rule.

As discussed above, marine mammal responses to sound (some of which are considered disturbances that rise to the level of a take) are highly variable and context specific, *i.e.,* they are affected by differences in acoustic conditions; differences between species and populations; differences in gender, age, reproductive status, or social behavior; and other prior experience of the individuals. This means that there is support for considering alternative approaches for estimating Level B harassment by behavioral disturbance. Although the statutory definition of Level B harassment for military readiness activities means that a natural behavior pattern of a marine mammal is significantly altered or abandoned, the current state of science for determining those thresholds is somewhat unsettled.

In its analysis of impacts associated with sonar acoustic sources (which was coordinated with NMFS), the Navy used an updated conservative approach that likely overestimates the number of takes by Level B harassment due to behavioral disturbance and response. Many of the behavioral responses identified using the Navy's quantitative analysis are most likely to be of moderate severity as described in the Southall *et al.* (2007) behavioral response severity scale. These ''moderate'' severity responses were considered significant if they were sustained for the duration of the exposure or longer. Within the Navy's quantitative analysis, many reactions are predicted from exposure to sound that may exceed an animal's threshold for Level B harassment by behavioral disturbance for only a single exposure (a few seconds) to several minutes, and it is likely that some of the resulting estimated behavioral responses that are counted as Level B harassment would not constitute ''significantly altering or abandoning natural behavioral patterns.'' The Navy and NMFS have used the best available science to address the challenging differentiation between significant and non-significant behavioral reactions (*i.e.,* whether the behavior has been abandoned or significantly altered such that it qualifies as harassment), but have erred on the cautious side where uncertainty exists (*e.g.,* counting these lower duration reactions as take), which likely results in some degree of overestimation of Level B harassment by behavioral disturbance. We consider application of these behavioral harassment thresholds, therefore, as identifying the maximum number of instances in which marine mammals could be reasonably expected to experience a disruption in behavior patterns to a point where they are abandoned or significantly altered (*i.e.,* Level B harassment). Because this is the most appropriate method for estimating Level B harassment given the best available science and uncertainty on the topic, it is these numbers of Level B harassment by behavioral disturbance that are analyzed in the Preliminary Analysis and Negligible Impact Determination section and would be authorized.

In the Navy's acoustic impact analyses during Phase II (the previous phase of Navy testing and training, 2017–2022, see also Navy's *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis Technical Report,* 2012), the likelihood of Level B harassment by behavioral disturbance in response to sonar and other transducers was based on a probabilistic function (termed a BRF), that related the likelihood (*i.e.,* probability) of a behavioral response (at the level of a Level B harassment) to the received SPL. The BRF was used to estimate the percentage of an exposed population that is likely to exhibit Level B harassment due to altered behaviors or behavioral disturbance at a given received SPL. This BRF relied on the assumption that sound poses a negligible risk to marine mammals if they are exposed to SPL below a certain ''basement'' value. Above the basement exposure SPL, the probability of a response increased with increasing SPL. Two BRFs were used in Navy acoustic impact analyses: BRF1 for mysticetes and BRF2 for other species. BRFs were not used for beaked whales during Phase II analyses. Instead, a step function at an SPL of 140 dB re: 1 μPa was used for beaked whales as the threshold to predict Level B harassment by behavioral disturbance. Similarly, a 120 dB re: 1 μP step function was used during Phase II for harbor porpoises.

Developing the behavioral harassment criteria for Phase III (the current phase of Navy training and testing activities) involved multiple steps: all available behavioral response studies conducted both in the field and on captive animals were examined to understand the breadth of behavioral responses of marine mammals to sonar and other transducers (see also Navy's *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III) Technical Report,* 2017). Six behavioral response field studies with observations of 14 different marine mammal species reactions to sonar or sonar-like signals and 6 captive animal behavioral studies with observations of 8 different species reactions to sonar or sonar-like signals were used to provide a robust data set for the derivation of the Navy's Phase III marine mammal behavioral response criteria. The current criteria have been rigorously vetted within the Navy community, among scientists during expert elicitation, and then reviewed by the public before being applied. All behavioral response research that has been published since the derivation of the Navy's Phase III criteria (December 2016) has been considered and is consistent with the current BRFs. While it is unreasonable to revise and update the criteria and risk functions every time a new study is published, these new studies provide additional information, and NMFS and the Navy are considering them for updates to the criteria in the future, when the next round of updated criteria will be developed. The Navy and NMFS continue to evaluate the information as new science becomes available.

Marine mammal species were placed into behavioral criteria groups based on their known or suspected behavioral sensitivities to sound. In most cases these divisions were driven by taxonomic classifications (*e.g.,* mysticetes, pinnipeds). The data from the behavioral studies were analyzed by looking for significant responses, or lack thereof, for each experimental session.

The Navy used cutoff distances beyond which the potential of significant behavioral responses (and therefore Level B harassment) is considered to be unlikely (see Table 7 below). These distances were determined by examining all available published field observations of behavioral reactions to sonar or sonar-like signals that included the distance between the sound source and the marine mammal. The longest distance, rounded up to the nearest 5-km increment, was chosen as the cutoff distance for each behavioral criteria group (*i.e.,* odontocetes, pinnipeds, mysticetes, beaked whales, and harbor porpoise). For animals within the cutoff distance, BRFs for each behavioral criteria group based on a received SPL as presented in Chapter 6, Section 6.4.2.1 (Methods for Analyzing Impacts from Sonars and other Transducers) of the Navy's rulemaking/LOA application were used to predict the probability of a potential significant behavioral response. For training activities that contain multiple platforms or tactical sonar sources that exceed 215 dB re: 1 μPa at 1 m, this cutoff distance is substantially increased (*i.e.,* doubled) from values derived from the literature. The use of multiple platforms and intense sound sources are factors that probably increase responsiveness in marine mammals overall (however, we note that helicopter dipping sonars were considered in the intense sound source group, despite lower source levels, because of data indicating that marine mammals are sometimes more responsive to the less predictable employment of this source). There are currently few behavioral observations under these circumstances; therefore, the Navy conservatively predicted significant behavioral responses that would rise to Level B harassment at farther ranges than shown in Table 7, versus less intense events.

TABLE 7—CUTOFF DISTANCES FOR MODERATE SOURCE LEVEL, SINGLE PLATFORM TRAINING EVENTS AND FOR ALL OTHER EVENTS WITH MULTIPLE PLATFORMS OR SONAR WITH SOURCE LEVELS AT OR EXCEEDING 215 dB re: 1 μPa at 1 m

Criteria group	Moderate SL/single platform cutoff distance (km)	High SL/multi-platform cutoff distance (km)
Odontocetes	10	20
Pinnipeds	5	10
Mysticetes	10	20
Beaked Whales	25	50
Harbor Porpoise	20	40

Notes: dB re: 1 μPa at 1 m = decibels referenced to 1 micropascal at 1 meter, km = kilometer, SL = source level.

The range to received sound levels in 6-dB steps from three representative sonar bins and the percentage of animals that may be taken by Level B harassment under each BRF are shown in Tables 8 through 10. Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff distance for a particular group and therefore are not included in the estimated take. See Chapter 6, Section 6.4.2.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) of the Navy's rulemaking/LOA application for further details on the derivation and use of the BRFs, thresholds, and the cutoff distances to identify takes by Level B harassment, which were coordinated with NMFS. As noted previously, NMFS carefully reviewed, and contributed to, the Navy's proposed behavioral harassment thresholds (*i.e.,* the BRFs and the cutoff distances) for the species, and agrees that these methods represent the best available science at this time for determining impacts to marine mammals from sonar and other transducers.

Tables 8 through 10 identify the maximum likely percentage of exposed individuals taken at the indicated received level and associated range (in which marine mammals would be reasonably expected to experience a disruption in behavior patterns to a point where they are abandoned or significantly altered) for mid-frequency active sonar (MFAS).

BILLING CODE 3510–22–P

Table 8-- Ranges to Estimated Level B Harassment by Behavioral Disturbance for Sonar Bin MF1 Over a Representative Range of Environments Within the TMAA

Received Level (dB re 1 µPa)	Mean Range (meters) with Minimum and Maximum Values in Parentheses	Probability of Behavioral Disturbance for Sonar Bin MF1 (Percent)				
		Beaked whales	Harbor Porpoise	Mysticetes	Odontocetes	Pinnipeds
196	105 (100–110)	100	100	100	100	100
190	240 (240–240)	100	100	98	100	100
184	498 (490–525)	100	100	88	99	98
178	1,029 (950–1,275)	100	100	59	97	92
172	3,798 (1,525–7,025)	99	100	30	91	76
166	8,632 (2,775–14,775)	97	100	20	78	48
160	15,000 (3,025–26,525)	93	100	18	58	27
154	23,025 (3,275–47,775)	83	100	17	40	18
148	47,693 (10,275–54,025)	66	100	16	29	16
142	53,834 (12,025–72,025)	45	100	13	25	15
136	60,035 (13,275–74,525)	28	100	9	23	15
130	72,207 (14,025–75,025)	18	100	5	20	15
124	73,169 (17,025–75,025)	14	100	2	17	14
118	72,993 (25,025–75,025)	12	0	1	12	13
112	72,940 (27,525–75,025)	11	0	0	6	9
106	73,016 (28,525–75,025)	11	0	0	3	5
100	73,320 (30,025–75,025)	8	0	0	1	2

Notes: (1) Cells are shaded if the mean range value for the specified received level exceeds the distance cut-off range for a particular hearing group. Any impacts within the cut-off range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels or multiple platforms. See Table 7 for behavioral cutoff distances. (2) dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

Table 9-- Ranges to Estimated Level B Harassment by Behavioral Disturbance for Sonar Bin MF4 Over a Representative Range of Environments Within the TMAA

Received Level (dB re 1 µPa)	Mean Range (meters) with Minimum and Maximum Values in Parentheses	Probability of Behavioral Disturbance for Sonar Bin MF4 (Percent)				
		Beaked whales	Harbor Porpoise	Mysticetes	Odontocetes	Pinnipeds
196	8 (0–8)	100	100	100	100	100
190	17 (0–17)	100	100	98	100	100
184	34 (0–35)	100	100	88	99	98
178	69 (0–75)	100	100	59	97	92
172	156 (120–190)	99	100	30	91	76
166	536 (280–1,000)	97	100	20	78	48
160	1,063 (470–1,775)	93	100	18	58	27
154	2,063 (675–4,275)	83	100	17	40	18
148	5,969 (1,025–9,275)	66	100	16	29	16
142	12,319 (1,275–26,025)	45	100	13	25	15
136	26,176 (1,775–40,025)	28	100	9	23	15
130	42,963 (2,275–54,775)	18	100	5	20	15
124	53,669 (2,525–65,775)	14	100	2	17	14
118	63,387 (2,775–75,025)	12	0	1	12	13
112	71,709 (3,025–75,025)	11	0	0	6	9
106	73,922 (22,775–75,025)	11	0	0	3	5
100	73,923 (25,525–75,025)	8	0	0	1	2

Notes: (1) Cells are shaded if the mean range value for the specified received level exceeds the distance cut-off range for a particular hearing group. Any impacts within the cut-off range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels or multiple platforms. See Table 7 for behavioral cutoff distances. (2) dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

Table 10-- Ranges to Estimated Level B Harassment by Behavioral Disturbance for Sonar Bin MF5 Over a Representative Range of Environments Within the TMAA

Received Level (dB re 1 µPa)	Mean Range (meters) with Minimum and Maximum Values in Parentheses	Probability of Behavioral Disturbance for Sonar Bin MF5 (Percent)				
		Beaked whales	Harbor Porpoise	Mysticetes	Odontocetes	Pinnipeds
196	0 (0–0)	100	100	100	100	100
190	1 (0–3)	100	100	98	100	100
184	4 (0–7)	100	100	88	99	98
178	14 (0–15)	100	100	59	97	92
172	29 (0–30)	99	100	30	91	76
166	59 (0–65)	97	100	20	78	48
160	130 (0–170)	93	100	18	58	27
154	349 (0–1,025)	83	100	17	40	18
148	849 (410–2,275)	66	100	16	29	16
142	1,539 (625–3,775)	45	100	13	25	15
136	2,934 (950–8,525)	28	100	9	23	15
130	6,115 (1,275–10,275)	18	100	5	20	15
124	9,764 (1,525–16,025)	14	100	2	17	14
118	13,830 (1,775–24,775)	12	0	1	12	13
112	18,970 (2,275–30,775)	11	0	0	6	9
106	25,790 (2,525–38,525)	11	0	0	3	5
100	36,122 (2,775–46,775)	8	0	0	1	2

Notes: (1) Cells are shaded if the mean range value for the specified received level exceeds the distance cut-off range for a particular hearing group. Any impacts within the cut-off range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels or multiple platforms. See Table 7 for behavioral cutoff distances. (2) dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

BILLING CODE 3510–22–C

Explosives

Phase III explosive criteria for behavioral harassment thresholds for marine mammals is the functional hearing groups' TTS onset threshold (in SEL) minus 5 dB (see Table 11 below and Table 6 for the TTS thresholds for explosives) for events that contain multiple impulses from explosives underwater. This is the same approach as taken in Phase II for explosive analysis. See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived. NMFS continues to concur that this approach represents the best available science for determining impacts to marine mammals from explosives. As noted previously, detonations occurring in air at a height of 33 ft (10 m) or less above the water surface, and detonations occurring directly on the water surface were modeled to detonate at a depth of 0.3 ft (0.1 m) below the water surface. There are no detonations of explosives occurring underwater as part of the planned activities.

TABLE 11—THRESHOLDS FOR LEVEL B HARASSMENT BY BEHAVIORAL DISTURBANCE FOR EXPLOSIVES FOR MARINE MAMMALS

Medium	Functional hearing group	SEL (weighted)
Underwater	Low-frequency cetaceans	163
Underwater	Mid-frequency cetaceans	165
Underwater	High-frequency cetaceans	135
Underwater	Phocids	165
Underwater	Otariids	183

Note: Weighted SEL thresholds in dB re: 1 µPa²s underwater

Navy's Acoustic Effects Model

The Navy's Acoustic Effects Model calculates sound energy propagation from sonar and other transducers and explosives during naval activities and the sound received by animat dosimeters. Animat dosimeters are virtual representations of marine mammals distributed in the area around the modeled naval activity and each dosimeter records its individual sound ''dose.'' The model bases the distribution of animats over the TMAA, the portion of the GOA Study Area where sonar and other transducers and explosives are proposed for use, on the density values in the Navy Marine Species Density Database and distributes animats in the water column proportional to the known time that species spend at varying depths.

The model accounts for environmental variability of sound propagation in both distance and depth when computing the sound level received by the animats. The model conducts a statistical analysis based on multiple model runs to compute the estimated effects on animals. The number of animats that exceed the thresholds for effects is tallied to provide an estimate of the number of marine mammals that could be affected.

Assumptions in the Navy model intentionally err on the side of overestimation when there are unknowns. Naval activities are modeled as though they would occur regardless of proximity to marine mammals, meaning that no mitigation is considered (*i.e.,* no power down or shut down modeled) and without any avoidance of the activity by the animal. 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. For more information on this process, see the discussion in the *Take Request* subsection below. All explosives used in the TMAA would detonate in the air at or above the water surface. However, for this analysis, detonations occurring in air at a height of 33 ft. (10 m) or less above the water surface, and detonations occurring directly on the water surface were modeled to detonate at a depth of 0.3 ft. (0.1 m) below the water surface since there is currently no other identified methodology for modeling potential effects to marine mammals that are underwater as a result of detonations occurring at or above the surface of the ocean. This overestimates the amount of explosive and acoustic energy entering the water.

The model estimates the impacts caused by individual training exercises. During any individual modeled event, impacts to individual animats are considered over 24-hour periods. The animats do not represent actual animals, but rather they represent a distribution of animals based on density and abundance data, which allows for a statistical analysis of the number of instances that marine mammals may be exposed to sound levels resulting in an effect. Therefore, the model estimates the number of instances in which an effect threshold was exceeded over the course of a year, but does not estimate the number of individual marine mammals that may be impacted over a year (*i.e.,* some marine mammals could be impacted several times, while others would not experience any impact). A detailed explanation of the Navy's Acoustic Effects Model is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

Range to Effects

This section provides range to effects for sonar and other active acoustic sources as well as explosives to specific acoustic thresholds determined using the Navy Acoustic Effects Model. Marine mammals exposed within these ranges for the shown duration are predicted to experience the associated effect. Range to effects is important information in not only predicting acoustic impacts, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals.

Sonar

The ranges to received sound levels in 6-dB steps from three representative sonar bins and the percentage of the total number of animals that may be disturbed (and therefore Level B harassment) under each BRF are shown in Table 8 though Table 10 above. See Chapter 6, Section 6.4.2.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) of the Navy's rulemaking/LOA application for additional details on the derivation and use of the BRFs, thresholds, and the cutoff distances that are used to identify Level B harassment by behavioral disturbance. NMFS has reviewed the range distance to effect data provided by the Navy and concurs with the analysis.

The ranges to PTS for three representative sonar systems for an exposure of 30 seconds is shown in Table 12 relative to the marine mammal's functional hearing group. This period (30 seconds) was chosen based on examining the maximum amount of time a marine mammal would realistically be exposed to levels that could cause the onset of PTS based on platform (*e.g.,* ship) speed and a nominal animal swim speed of approximately 1.5 m per second. The ranges provided in the table include the average range to PTS, as well as the range from the minimum to the maximum distance at which PTS is possible for each hearing group.

TABLE 12—RANGES TO PERMANENT THRESHOLD SHIFT (METERS) FOR THREE REPRESENTATIVE SONAR SYSTEMS

Hearing group	Approximate range in meters for PTS from 30 second exposure [1]		
	Sonar bin MF1	Sonar bin MF4	Sonar bin MF5
High-frequency cetaceans	180 (180–180)	31 (30–35)	9 (8–10)
Low-frequency cetaceans	65 (65–65)	13 (0–15)	0 (0–0)
Mid-frequency cetaceans	16 (16–16)	3 (3–3)	0 (0–0)
Otariids [2]	6 (6–6)	0 (0–0)	0 (0–0)
Phocids [2]	45 (45–45)	11 (11–11)	0 (0–0)

[1] PTS ranges extend from the sonar or other transducer sound source to the indicated distance. The average range to PTS is provided as well as the range from the estimated minimum to the maximum range to PTS in parenthesis.

[2] Otariids and phocids are separated because true seals (phocids) generally dive much deeper than sea lions and fur seals (otariids).

Notes: MF = mid-frequency, PTS = permanent threshold shift.

The tables below illustrate the range to TTS for 1, 30, 60, and 120 seconds from three representative sonar systems (see Table 13 through Table 15).

TABLE 13—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN MF1 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE TMAA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF1			
	1 second	30 seconds	60 seconds	120 seconds
High-frequency cetaceans	3,554 (1,525–6,775)	3,554 (1,525–6,775)	5,325 (2,275–9,525)	7,066 (2,525–13,025)
Low-frequency cetaceans	920 (850–1,025)	920 (850–1,025)	1,415 (1,025–2,025)	2,394 (1,275–4,025)
Mid-frequency cetaceans	209 (200–210)	209 (200–210)	301 (300–310)	376 (370–390)
Otariids	65 (65–65)	65 (65–65)	100 (100–110)	132 (130–140)
Phocids	673 (650–725)	673 (650–725)	988 (900–1,025)	1,206 (1,025–1,525)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the TMAA. The zone in which animals are expected to incur TTS extends from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.
Notes: MF = mid-frequency, TTS = temporary threshold shift.

TABLE 14—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN MF4 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE TMAA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF4			
	1 second	30 seconds	60 seconds	120 seconds
High-frequency cetaceans	318 (220–550)	686 (430–1,275)	867 (575–1,525)	1,225 (825–2,025)
Low-frequency cetaceans	77 (0–100)	175 (130–340)	299 (190–550)	497 (280–1,000)
Mid-frequency cetaceans	22 (22–22)	35 (35–35)	50 (50–50)	71 (70–75)
Otariids	8 (8–8)	15 (15–15)	19 (19–19)	25 (25–25)
Phocids	67 (65–70)	123 (110–150)	172 (150–210)	357 (240–675)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the TMAA. The zone in which animals are expected to incur TTS extends from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.
Notes: MF = mid-frequency, TTS = temporary threshold shift.

TABLE 15—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN MF5 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE TMAA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF5			
	1 second	30 seconds	60 seconds	120 seconds
High-frequency cetaceans	117 (110–140)	117 (110–140)	176 (150–320)	306 (210–800)
Low-frequency cetaceans	9 (0–12)	9 (0–12)	13 (0–17)	19 (0–24)
Mid-frequency cetaceans	5 (0–9)	5 (0–9)	12 (11–13)	18 (17–18)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	9 (8–10)	9 (8–10)	14 (14–15)	21 (21–22)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the TMAA. The zone in which animals are expected to incur TTS extends from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.
Notes: MF = mid-frequency, TTS = temporary threshold shift.

Explosives

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria (see Chapter 6, Section 6.5.2 (Impacts from Explosives) of the Navy's rulemaking/LOA application and the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c)) and the explosive propagation calculations from the Navy Acoustic Effects Model (see Chapter 6, Section 6.5.2.2 (Impact Ranges for Explosives) of the Navy's rulemaking/LOA application). The range to effects are shown for a range of explosive bins, from E5 (greater than 5–10 lbs net explosive weight) to E12 (greater than 650 lbs to 1,000 lbs net explosive weight) (Tables 16 through 29). Ranges are determined by modeling the distance that noise from an explosion would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response (to the degree of Level B harassment), TTS, PTS, and non-auditory injury. NMFS has reviewed the range distance to effect data provided by the Navy and concurs with the analysis. Range to effects is important information in not only predicting impacts from explosives, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals. For additional information on how ranges to impacts from explosions were estimated, see the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Navy, 2018).

Tables 16 through 27 show the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment based on the developed thresholds. Ranges are provided for a representative source depth and cluster size (the number of rounds fired, or buoys dropped, within a very short duration) for each bin. For events with multiple explosions, sound from successive explosions can be expected to accumulate and increase the range to the onset of an impact based on SEL thresholds. Ranges to non-auditory injury and mortality are shown in Table 28 and Table 29, respectively.

No underwater detonations are planned as part of the Navy's activities, but marine mammals could be exposed to in-air detonations at or above the water surface. The Navy Acoustic Effects Model cannot account for the highly non-linear effects of cavitation and surface blow off for shallow underwater explosions, nor can it estimate the explosive energy entering the water from a low-altitude detonation. Thus, for this analysis, sources detonating in-air at or above (within 10 m above) the water surface are modeled as if detonating completely underwater at a depth of 0.1 m, with all energy reflected into the water rather than released into the air. Therefore, the amount of explosive and acoustic energy entering the water, and consequently the estimated ranges to effects, are likely to be overestimated.

Table 16 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for high-frequency cetaceans based on the developed thresholds.

TABLE 16—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR HIGH-FREQUENCY CETACEANS

Range to effects for explosives: high-frequency cetaceans [1]					
Bin [2]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	910 (850–975)	1,761 (1,275–2,275)	2,449 (1,775–3,275)
		7	1,275 (1,025–1,525)	3,095 (2,025–4,525)	4,664 (2,275–7,775)
E9	0.1	1	1,348 (1,025–1,775)	3,615 (2,025–5,775)	5,365 (2,525–8,525)
E10	0.1	1	1,546 (1,025–2,025)	4,352 (2,275–7,275)	5,949 (2,525–9,275)
E12	0.1	1	1,713 (1,275–2,025)	5,115 (2,275–7,775)	6,831 (2,775–10,275)

[1] Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift.

[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 17 shows the minimum, average, and maximum ranges to onset of auditory effects for high-frequency cetaceans based on the developed thresholds.

TABLE 17—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR HIGH FREQUENCY CETACEANS

Range to effects for explosives: high-frequency cetaceans [1]				
Bin [2]	Source depth (m)	Cluster size	PTS	TTS
E5	0.1	1	1,161 (1,000–1,525)	1,789 (1,025–2,275)
		7	1,161 (1,000–1,525)	1,789 (1,025–2,275)
E9	0.1	1	2,331 (1,525–2,775)	5,053 (2,025–9,275)
E10	0.1	1	2,994 (1,775–4,525)	7,227 (2,025–14,775)
E12	0.1	1	4,327 (2,025–7,275)	10,060 (2,025–22,275)

[1] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.

[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 18 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for low-frequency cetaceans based on the developed thresholds.

TABLE 18—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR LOW-FREQUENCY CETACEANS

Range to effects for explosives: low-frequency cetaceans [1]					
Bin [2]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	171 (100–190)	633 (230–825)	934 (310–1,525)
		7	382 (170–450)	1,552 (380–5,775)	3,712 (600–13,025)
E9	0.1	1	453 (180–550)	3,119 (550–9,025)	6,462 (1,275–19,275)
E10	0.1	1	554 (210–700)	4,213 (600–13,025)	9,472 (1,775–27,275)
E12	0.1	1	643 (230–825)	6,402 (1,275–19,775)	13,562 (2,025–34,775)

[1] Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 19 shows the minimum, average, and maximum ranges to onset of auditory effects for low-frequency cetaceans based on the developed thresholds.

TABLE 19—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR LOW FREQUENCY CETACEANS

Range to effects for explosives: low-frequency cetaceans [1]				
Bin [2]	Source depth (m)	Cluster size	PTS	TTS
E5	0.1	1	419 (170–500)	690 (210–875)
		7	419 (170–500)	690 (210–875)
E9	0.1	1	855 (270–1,275)	1,269 (400–1,775)
E10	0.1	1	953 (300–1,525)	1,500 (450–2,525)
E12	0.1	1	1,135 (360–1,525)	1,928 (525–4,775)

[1] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 20 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for mid-frequency cetaceans based on the developed thresholds.

TABLE 20—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR MID-FREQUENCY CETACEANS

Range to effects for explosives: mid-frequency cetaceans [1]					
Bin [2]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	79 (75–80)	363 (360–370)	581 (550–600)
		7	185 (180–190)	777 (650–825)	1,157 (800–1,275)
E9	0.1	1	215 (210–220)	890 (700–950)	1,190 (825–1,525)
E10	0.1	1	275 (270–280)	974 (750–1,025)	1,455 (875–1,775)
E12	0.1	1	340 (340–340)	1,164 (825–1,275)	1,746 (925–2,025)

[1] Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 21 shows the minimum, average, and maximum ranges to onset of auditory effects for mid-frequency cetaceans based on the developed thresholds.

TABLE 21—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR MID-FREQUENCY CETACEANS

Range to effects for explosives: mid-frequency cetaceans[1]				
Bin[2]	Source depth (m)	Cluster size	PTS	TTS
E5	0.1	1	158 (150–160)	295 (290–300)
		7	158 (150–160)	295 (290–300)
E9	0.1	1	463 (430–470)	771 (575–850)
E10	0.1	1	558 (490–575)	919 (625–1,025)
E12	0.1	1	679 (550–725)	1,110 (675–1,275)

[1] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 22 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for otariid pinnipeds based on the developed thresholds.

TABLE 22—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR OTARIIDS

Range to effects for explosives: otariids[1]					
Bin[2]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	25 (24–25)	110 (110–110)	185 (180–190)
		7	58 (55–60)	265 (260–270)	443 (430–450)
E9	0.1	1	68 (65–70)	320 (310–330)	512 (490–525)
E10	0.1	1	88 (85–90)	400 (390–410)	619 (575–675)
E12	0.1	1	105 (100–110)	490 (470–500)	733 (650–825)

[1] Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 23 shows the minimum, average, and maximum ranges to onset of auditory effects for otariid pinnipeds based on the developed thresholds.

TABLE 23—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR OTARIIDS

Range to effects for explosives: otariids[1]				
Bin[2]	Source depth (m)	Cluster Size	PTS	TTS
E5	0.1	1	128 (120–130)	243 (240–250)
		7	128 (120–130)	243 (240–250)
E9	0.1	1	383 (380–390)	656 (600–700)
E10	0.1	1	478 (470–480)	775 (675–850)
E12	0.1	1	583 (550–600)	896 (750–1,025)

[1] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[2] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 24 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for phocid pinnipeds, excluding elephant seals, based on the developed thresholds.

TABLE 24—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR PHOCIDS, EXCLUDING ELEPHANT SEALS

Range to effects for explosives: phocids [1]					
Bin [2]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	150 (150–150)	681 (675–700)	1,009 (975–1,025)
		7	360 (350–370)	1,306 (1,025–1,525)	1,779 (1,275–2,275)
E9	0.1	1	425 (420–430)	1,369 (1,025–1,525)	2,084 (1,525–2,775)
E10	0.1	1	525 (525–525)	1,716 (1,275–2,275)	2,723 (1,525–4,025)
E12	0.1	1	653 (650–675)	1,935 (1,275–2,775)	3,379 (1,775–5,775)

[1] Excluding elephant seals.
[2] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[3] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 25 shows the minimum, average, and maximum ranges to onset of auditory effects for phocids pinnipeds, excluding elephant seals, based on the developed thresholds.

TABLE 25—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR PHOCIDS, EXCLUDING ELEPHANT SEALS

Range to effects for explosives: phocids [1]				
Bin [2]	Source depth (m)	Cluster size	PTS	TTS
E5	0.1	1	537 (525–550)	931 (875–975)
		7	537 (525–550)	931 (875–975)
E9	0.1	1	1,150 (1,025–1,275)	1,845 (1,275–2,525)
E10	0.1	1	1,400 (1,025–1,775)	2,067 (1,275–2,525)
E12	0.1	1	1,713 (1,275–2,025)	2,306 (1,525–2,775)

[1] Excluding elephant seals.
[2] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[3] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 26 shows the minimum, average, and maximum ranges to onset of auditory and likely behavioral effects that rise to the level of Level B harassment for elephant seals based on the developed thresholds.

TABLE 26—SEL-BASED RANGES TO ONSET PTS, ONSET TTS, AND BEHAVIORAL DISTURBANCE (IN METERS) FOR ELEPHANT SEALS [1]

Range to effects for explosives: phocids (elephant seals) [2]					
Bin [3]	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E5	0.1	1	150 (150–150)	688 (675–700)	1,025 (1,025–1,025)
		7	360 (350–370)	1,525 (1,525–1,525)	2,345 (2,275–2,525)
E9	0.1	1	425 (420–430)	1,775 (1,775–1,775)	2,858 (2,775–3,275)
E10	0.1	1	525 (525–525)	2,150 (2,025–2,525)	3,421 (3,025–4,025)
E12	0.1	1	656 (650–675)	2,609 (2,525–3,025)	4,178 (3,525–5,775)

[1] Elephant seals are separated from other phocids due to their dive behavior, which far exceeds the dive depths of the other phocids analyzed.
[2] Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift.
[3] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 27 shows the minimum, average, and maximum ranges to onset of auditory effects for elephant seals, based on the developed thresholds.

TABLE 27—PEAK PRESSURE-BASED RANGES TO ONSET PTS AND ONSET TTS (IN METERS) FOR ELEPHANT SEALS [1]

Range to effects for explosives: phocids (elephant seals) [2]				
Bin [3]	Source depth (m)	Cluster size	PTS	TTS
E5	0.1	1	537 (525–550)	963 (950–975)
		7	537 (525–550)	963 (950–975)
E9	0.1	1	1,275 (1,275–1,275)	2,525 (2,525–2,525)
E10	0.1	1	1,775 (1,775–1,775)	3,046 (3,025–3,275)
E12	0.1	1	2,025 (2,025–2,025)	3,539 (3,525–3,775)

[1] Elephant seals are separated from other phocids due to their dive behavior, which far exceeds the dive depths of the other phocids analyzed.
[2] Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. No underwater explosions are planned. The model assumes that all explosive energy from detonations at or above (within 10 m) the water surface is released underwater, likely over-estimating ranges to effect. PTS = permanent threshold shift, TTS = temporary threshold shift.
[3] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).

Table 28 shows the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury as a function of animal mass and explosive bin (*i.e.,* net explosive weight). Ranges to gastrointestinal tract injury typically exceed ranges to slight lung injury; therefore, the maximum range to effect is not mass-dependent. Animals within these water volumes would be expected to receive minor injuries at the outer ranges, increasing to more substantial injuries, and finally mortality as an animal approaches the detonation point.

TABLE 28—RANGES TO 50 PERCENT NON-AUDITORY INJURY FOR ALL MARINE MAMMAL HEARING GROUPS

Bin [1]	Range to non-auditory injury (meters) [2]
E5	40 (40–40)
E9	121 (90–130)
E10	152 (100–160)
E12	190 (110–200)

[1] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).
[2] Average distance (m) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
Notes: All ranges to non-auditory injury within this table are driven by gastrointestinal tract injury thresholds regardless of animal mass.

Ranges to mortality, based on animal mass, are shown in Table 29 below.

TABLE 29—RANGES TO 50 PERCENT MORTALITY RISK FOR ALL MARINE MAMMAL HEARING GROUPS AS A FUNCTION OF ANIMAL MASS

Bin [1]	Animal mass intervals (kg) [2]					
	10	250	1,000	5,000	25,000	72,000
E5	13 (12–14)	7 (4–11)	3 (3–4)	2 (1–3)	1 (1–1)	1 (0–1)
E9	35 (30–40)	20 (13–30)	10 (9–13)	7 (6–9)	4 (3–4)	3 (2–3)
E10	43 (40–50)	25 (16–40)	13 (11–16)	9 (7–11)	5 (4–5)	4 (3–4)
E12	55 (50–60)	30 (20–50)	17 (14–20)	11 (9–14)	6 (5–7)	5 (4–6)

[1] Bin (net explosive weight, lb.): E5 (>5–10), E9 (>100–250), E10 (>250–500), E12 (>650–1,000).
[2] Average distance (m) to mortality is depicted above the minimum and maximum distances, which are in parentheses for each animal mass interval.

Marine Mammal Density

A quantitative analysis of impacts on a species or stock requires data on their abundance and distribution that may be affected by anthropogenic activities in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is 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 mammal 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. This is the general approach applied in estimating cetacean abundance in NMFS' Stock Assessment Reports (SARs). 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, spatial habitat modeling developed by NMFS' Southwest Fisheries Science Center has been used to estimate cetacean densities (Barlow *et al.,* 2009; Becker *et al.,* 2010, 2012a, 2012b, 2012c, 2014, 2016; Ferguson *et al.,* 2006a; Forney *et al.,* 2012, 2015; 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 and for areas that have not been surveyed. Within the geographic area that was modeled, densities can be predicted wherever these habitat variables can be measured or estimated.

Ideally, density data would be available for all species throughout the study area year-round, in order to best estimate the impacts of Navy activities on marine species. However, in many places ship availability, lack of funding, inclement weather conditions, and high sea states prevent the completion of comprehensive year-round surveys. Even with surveys that are completed, poor conditions may result in lower sighting rates for species that would typically be sighted with greater frequency under favorable conditions. Lower sighting rates preclude having an acceptably low uncertainty in the density estimates. A high level of uncertainty, indicating a low level of confidence in the density estimate, is typical for species that are rare or difficult to sight. In areas where survey data are limited or non-existent, known or inferred associations between marine habitat features and the likely presence of specific species are sometimes used to predict densities in the absence of actual animal sightings. Consequently, there is no single source of density data for every area, species, and season because of the fiscal costs, resources, and effort involved in providing enough survey coverage to sufficiently estimate density.

To characterize marine species density for large oceanic regions, the Navy reviews, critically assesses, and prioritizes existing density estimates from multiple sources, requiring the development of a systematic method for selecting the most appropriate density estimate for each combination of species/stock, area, and season. The selection and compilation of the best available marine species density data resulted in the Navy Marine Species Density Database (NMSDD), which includes seasonal density values for every marine mammal species and stock present within the TMAA. This database is described in the technical report titled *U.S. Navy Marine Species Density Database Phase III for the Gulf of Alaska Temporary Maritime Activities Area* (U.S. Department of the Navy, 2021), hereafter referred to as the Density Technical Report. NMFS vetted all cetacean densities by the Navy prior to use in the Navy's acoustic analysis for the current rulemaking process.

A variety of density data and density models are needed in order to develop a density database that encompasses the entirety of the TMAA (densities beyond the TMAA were not considered because sonar and other transducers and explosives would not be used in the GOA Study Area beyond the TMAA). Because this data is collected using different methods with varying amounts of accuracy and uncertainty, the Navy has developed a hierarchy to ensure the most accurate data is used when available. The Density Technical Report describes these models in detail and provides detailed explanations of the models applied to each species density estimate. The below list describes models in order of preference.

1. Spatial density models are preferred and used when available because they provide an estimate with the least amount of uncertainty by deriving estimates for divided segments of the sampling area. These models (see Becker *et al.,* 2016; Forney *et al.,* 2015) predict spatial variability of animal presence as a function of habitat variables (*e.g.,* sea surface temperature, seafloor depth, *etc.*). This model is developed for areas, species, and, when available, specific timeframes (months or seasons) with sufficient survey data; therefore, this model cannot be used for species with low numbers of sightings.

2. Stratified design-based density estimates use line-transect survey data with the sampling area divided (stratified) into sub-regions, and a density is predicted for each sub-region (see Barlow, 2016; Becker *et al.,* 2016; Bradford *et al.,* 2017; Campbell *et al.,* 2014; Jefferson *et al.,* 2014). While geographically stratified density estimates provide a better indication of a species' distribution within the study area, the uncertainty is typically high because each sub-region estimate is based on a smaller stratified segment of the overall survey effort.

3. Design-based density estimations use line-transect survey data from vessel and aerial surveys designed to cover a specific geographic area (see Carretta *et al.,* 2015). These estimates use the same survey data as stratified design-based estimates, but are not segmented into sub-regions and instead provide one estimate for a large surveyed area.

Relative environmental suitability (RES) models provide estimates for areas of the oceans that have not been surveyed using information on species occurrence and inferred habitat associations and have been used in past density databases, however, these models were not used in the current quantitative analysis.

The Navy describes some of the challenges of interpreting the results of the quantitative analysis summarized above and described in the Density Technical Report: ''It is important to consider that even the best estimate of marine species density is really a model representation of the values of concentration where these animals might occur. Each model is limited to the variables and assumptions considered by the original data source provider. No mathematical model representation of any biological population is perfect, and with regards to marine mammal biodiversity, any single model method will not completely explain the actual distribution and abundance of marine mammal species. It is expected that there would be anomalies in the results that need to be evaluated, with independent information for each case, to support if we might accept or reject a model or portions of the model'' (U.S. Department of the Navy, 2017a).

The Navy's estimate of abundance (based on the density estimates used) in the TMAA may differ from population abundances estimated in NMFS' SARs in some cases for a variety of reasons. Models may predict different population abundances for many reasons. The models may be based on different data sets or different temporal predictions may be made. The SARs are often based on single years of NMFS surveys, whereas the models used by the Navy generally include multiple years of survey data from NMFS, the Navy, and other sources. To present a single, best estimate, the SARs often use a single season survey where they have the best spatial coverage (generally summer). Navy models often use predictions for multiple seasons, where appropriate for the species, even when survey coverage in non-summer seasons is limited, to characterize impacts over multiple seasons as Navy activities may occur outside of the summer months. Predictions may be made for different spatial extents. Many different, but equally valid, habitat and density modeling techniques exist and these can also be the cause of differences in population predictions. Differences in population estimates may be caused by a combination of these factors. Even similar estimates should be interpreted with caution and differences in models fully understood before drawing conclusions.

In particular, the global population structure of humpback whales, with 14 DPSs all associated with multiple feeding areas at which individuals from multiple DPSs convene, is another reason that SAR abundance estimates can differ from other estimates and be somewhat confusing—the same individuals are addressed in multiple

SARs. For some species, the stock assessment for a given species may exceed the Navy's density prediction because those species' home range extends beyond the GOA Study Area or TMAA boundaries. The primary source of density estimates are geographically specific survey data and either peer-reviewed line-transect estimates or habitat-based density models that have been extensively validated to provide the most accurate estimates possible.

These factors and others described in the Density Technical Report should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

NMFS coordinated with the Navy in the development of its take estimates and concurs that the Navy's approach for density appropriately utilizes the best available science. Later, in the Preliminary Analysis and Negligible Impact Determination section, we assess how the estimated take numbers compare to stock abundance in order to better understand the potential number of individuals impacted, and the rationale for which abundance estimate is used is included there.

Take Request

The 2020 GOA DSEIS/OEIS considered all training activities proposed to occur in the TMAA, and the 2022 Supplement to the 2020 GOA DSEIS/OEIS considered all training activities proposed to occur in the WMA, together for which they covered all activities proposed for the GOA Study Area. The Navy's rulemaking/LOA application described the activities that are reasonably likely to result in the MMPA-defined take of marine mammals, all of which would occur in the TMAA portion of the GOA Study Area. The Navy determined that the two stressors below could result in the incidental taking of marine mammals. NMFS has reviewed the Navy's data and analysis for the entire Study Area and determined that it is complete and accurate, and agrees that the following stressors have the potential to result in takes by harassment of marine mammals from the Navy's planned activities.

• Acoustics (sonar and other transducers); and

• Explosives (explosive shock wave and sound, assumed to encompass the risk due to fragmentation).

The quantitative analysis process used to estimate potential exposures to marine mammals resulting from acoustic and explosive stressors for the Navy's take request in the rulemaking/LOA application and the 2020 GOA DSEIS/OEIS is detailed in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018). The Navy Acoustic Effects Model estimates acoustic and explosive effects without taking mitigation into account; therefore, the model overestimates predicted impacts on marine mammals within mitigation zones.

To account for mitigation for marine species in the take estimates, the Navy conducts a quantitative assessment of mitigation. The Navy conservatively quantifies the manner in which procedural mitigation is expected to reduce the risk for model-estimated PTS for exposures to sonars and for model-estimated mortality for exposures to explosives, based on species sightability, observation area, visibility, and the ability to exercise positive control over the sound source. Where the analysis indicates mitigation would effectively reduce risk, the model-estimated PTS are considered reduced to TTS and the model-estimated mortalities are considered reduced to injury, though, for training activities in the GOA Study Area, no mortality or non-auditory injury is anticipated, even without consideration of planned mitigation measures. For a complete explanation of the process for assessing the effects of mitigation, see the Navy's rulemaking/LOA application (Section 6: Take Estimates for Marine Mammals, and Section 11: Mitigation Measures) and the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018). The extent to which the mitigation areas reduce impacts on the affected species is addressed separately in the Preliminary Analysis and Negligible Impact Determination section.

The Navy assesses the effectiveness of its procedural mitigation measures on a per-scenario basis for four factors: (1) species sightability, (2) a Lookout's ability to observe the range to PTS (for sonar and other transducers) and range to mortality (for explosives, although for this rule the Navy's modeling indicated that no mortality would occur), (3) the portion of time when mitigation could potentially be conducted during periods of reduced daytime visibility (to include inclement weather and high sea-state) and the portion of time when mitigation could potentially be conducted at night, and (4) the ability for sound sources to be positively controlled (*e.g.,* powered down).

During training activities, there is typically at least one, if not numerous, support personnel involved in the activity (*e.g.,* range support personnel aboard a torpedo retrieval boat or support aircraft). In addition to the Lookout posted for the purpose of mitigation, these additional personnel observe and disseminate marine species sighting information amongst the units participating in the activity whenever possible as they conduct their primary mission responsibilities. However, as a conservative approach to assigning mitigation effectiveness factors, the Navy elected to only account for the minimum number of required Lookouts used for each activity; therefore, the mitigation effectiveness factors may underestimate the likelihood that some marine mammals may be detected during activities that are supported by additional personnel who may also be observing the mitigation zone.

For a rulemaking where NMFS and the Navy determine that the planned activities, such as use of explosives, could cause mortality, the Navy would use the equations in the below sections to calculate the reduction in model-estimated mortality impacts due to implementing procedural mitigation.

Equation 1:

Mitigation Effectiveness = Species Sightability × Visibility × Observation Area × Positive Control

Species Sightability is the ability to detect marine mammals and is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability. The Navy considered applicable data from the best available science to numerically approximate the sightability of marine mammals and determined the standard ''detection probability'' referred to as g(0) is most appropriate. Also, Visibility = 1 − sum of individual visibility reduction factors; Observation Area = portion of impact range that can be continuously observed during an event; and Positive Control = positive control factor of all sound sources involving mitigation. For further details on these mitigation effectiveness factors please refer to the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

To quantify the number of marine mammals predicted to be sighted by Lookouts in the injury zone during implementation of procedural mitigation for sonar and other transducers, the species sightability is multiplied by the mitigation effectiveness scores and number of model-estimated PTS impacts, as shown in the equation below:

Equation 2:

Number of Animals Sighted by Lookouts = Mitigation Effectiveness × Model − Estimated Impacts

The marine mammals sighted by Lookouts in the injury zone during implementation of mitigation, as calculated by the equation above, would not be exposed to these higher level impacts. To quantify the number of marine mammals predicted to be sighted by Lookouts in the mortality zone during implementation of procedural mitigation during events using explosives (if any mortality were anticipated to occur), the species sightability is multiplied by the mitigation effectiveness scores and number of model-estimated mortality impacts, as shown in equation 1 above. The marine mammals predicted to be sighted in the mortality zone by Lookouts during implementation of procedural mitigation, as calculated by the above equation 2, are not predicted to be exposed in these ranges. The Navy corrects the category of predicted impact for the number of animals sighted within the mitigation zone, but does not modify the total number of animals predicted to experience impacts from the scenario. For example, the number of animals sighted (*i.e.,* number of animals that will avoid mortality) is first subtracted from the model-predicted mortality impacts, and then added to the model-predicted injurious impacts.

The NAEMO model overestimates the number of marine mammals that would be exposed to sound sources that could cause PTS because the model does not consider horizontal movement of animats, including avoidance of high intensity sound exposures. Therefore, the potential for animal avoidance is considered separately. At close ranges and high sound levels, avoidance of the area immediately around the sound source is one of the assumed behavioral responses for marine mammals. Animal avoidance refers to the movement out of the immediate injury zone for subsequent exposures, not wide-scale area avoidance. Various researchers have demonstrated that cetaceans can perceive the location and movement of a sound source (*e.g.,* vessel, seismic source, etc.) relative to their own location and react with responsive movement away from the source, often at distances of 1 km or more (Au and Perryman, 1982; Jansen *et al.,* 2010; Richardson *et al.,* 1995; Tyack *et al.,* 2011; Watkins, 1986; Würsig *et al.,* 1998). A marine mammal's ability to avoid a sound source and reduce its cumulative sound energy exposure would reduce risk of both PTS and TTS. However, the quantitative analysis conservatively only considers the potential to reduce some instances of PTS by accounting for marine mammals swimming away to avoid repeated high-level sound exposures. All reductions in PTS impacts from likely avoidance behaviors are instead considered TTS impacts.

NMFS coordinated with the Navy in the development of this quantitative method to address the effects of procedural mitigation on acoustic and explosive exposures and takes, and NMFS independently reviewed and concurs with the Navy that it is appropriate to incorporate the quantitative assessment of mitigation into the take estimates based on the best available science. We reiterate, however, that no mortality was modeled for the GOA TMAA activities, and as stated above, the Navy does not propose the use of sonar and other transducers and explosives in the WMA. Therefore, this method was not applied here, as it relates to modeled mortality. This method was applied to potential takes by PTS resulting from sonar and other transducers in the TMAA, but not for the use of explosives. For additional information on the quantitative analysis process and mitigation measures, refer to the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018) and Chapter 6 (*Take Estimates for Marine Mammals*) and Chapter 11 (*Mitigation Measures*) of the Navy's rulemaking/LOA application.

As a general matter, NMFS does not prescribe the methods for estimating take for any applicant, but we review and ensure that applicants use the best available science, and methodologies that are logical and technically sound. Applicants may use different methods of calculating take (especially when using models) and still get to a result that is representative of the best available science and that allows for a rigorous and accurate evaluation of the effects on the affected populations. There are multiple pieces of the Navy take estimation methods—propagation models, animat movement models, and behavioral thresholds, for example. NMFS evaluates the acceptability of these pieces as they evolve and are used in different rules and impact analyses. Some of the pieces of the Navy's take estimation process have been used in Navy incidental take rules since 2009 and have undergone multiple public comment processes; all of them have undergone extensive internal Navy review, and all of them have undergone comprehensive review by NMFS, which has sometimes resulted in modifications to methods or models.

The Navy uses rigorous review processes (verification, validation, and accreditation processes; peer and public review) to ensure the data and methodology it uses represent the best available science. For instance, the NAEMO model is the result of a NMFS-led Center for Independent Experts (CIE) review of the components used in earlier models. The acoustic propagation component of the NAEMO model (CASS/GRAB) is accredited by the Oceanographic and Atmospheric Master Library (OAML), and many of the environmental variables used in the NAEMO model come from approved OAML databases and are based on in-situ data collection. The animal density components of the NAEMO model are base products of the NMSDD, which includes animal density components that have been validated and reviewed by a variety of scientists from NMFS Science Centers and academic institutions. Several components of the model, for example the Duke University habitat-based density models, have been published in peer reviewed literature. Others like the Atlantic Marine Assessment Program for Protected Species, which was conducted by NMFS Science Centers, have undergone quality assurance and quality control (QA/QC) processes. Finally, the NAEMO model simulation components underwent QA/QC review and validation for model parts such as the scenario builder, acoustic builder, scenario simulator, *etc.,* conducted by qualified statisticians and modelers to ensure accuracy. Other models and methodologies have gone through similar review processes.

In summary, we believe the Navy's methods, including the underlying NAEMO modeling and the method for incorporating mitigation and avoidance, are the most appropriate methods for predicting non-auditory injury, PTS, TTS, and behavioral disturbance. But even with the consideration of mitigation and avoidance, given some of the more conservative components of the methodology (*e.g.,* the thresholds do not consider ear recovery between pulses), we would describe the application of these methods as identifying the maximum number of instances in which marine mammals would be reasonably expected to be taken through non-auditory injury, PTS, TTS, or behavioral disturbance.

Summary of Requested Take From Training Activities

Based on the methods discussed in the previous sections and the Navy's model and quantitative assessment of mitigation, the Navy provided its take estimate and request for authorization of takes incidental to the use of acoustic and explosive sources for training activities both annually (based on the maximum number of activities that could occur per 12-month period) and over the 7-year period covered by the Navy's rulemaking/LOA application. The following species/stocks present in the TMAA were modeled by the Navy and estimated to have 0 takes of any type from any activity source: Western North Pacific stock of humpback whale; Eastern North Pacific and Western North Pacific stocks of gray whales; Eastern North Pacific Alaska Resident and AT1 Transient stocks of killer whales; Gulf of Alaska and Southeast Alaska stocks of harbor porpoises; U.S. stock of California sea lion; Eastern U.S. and Western U.S. stock of Steller sea lion; Cook Inlet/Shelikof Strait, North Kodiak, Prince William Sound, and South Kodiak stocks of harbor seals, and Alaska stock of Ribbon seals.

The Phase II rule (82 FR 19530; April 26, 2017), valid from April 2017 to April 2022, authorized Level B harassment take of the Eastern North Pacific Alaska Resident stock of killer whales, Gulf of Alaska and Southeast Alaska stocks of harbor porpoise, California sea lion, Eastern U.S. and Western U.S. stock of Steller sea lion, and South Kodiak and Prince William Sound stocks of harbor seal. Takes of these stocks in Phase II were all expected to occur as a result of exposure to sonar activity, rather than explosive use. Inclusion of new density/distribution information and updated BRFs and corresponding cut-offs resulted in 0 estimated takes for these species and stocks in this rulemaking for Phase III.

NMFS has reviewed the Navy's data, methodology, and analysis for the current phase of rulemaking (Phase III) and determined that it is complete and accurate. However, NMFS has conservatively proposed to include incidental take of the Western North Pacific stock of humpback whale and Eastern North Pacific stock of gray whale, for the following reasons. For the Western North Pacific stock of humpback whale, in calculating takes by Level B harassment from sonar in Phase III, the application of the Phase III BRFs with corresponding cut-offs (20 km for mysticetes), in addition to the stock guild breakout which assigns 0.05 percent of the take of humpback whales to the Western North Pacific stock, generated a near-zero result, which the Navy rounded to zero in its rulemaking/LOA application. However, NMFS authorized take of one Western North Pacific humpback whale in the Phase II LOA, and, given that they do occur in the area, NMFS is conservatively proposing to authorize take by Level B harassment of one group (3 animals) annually in this Phase III rulemaking. The annual take estimate of 3 animals reflects the average group size of on and off-effort survey sightings of humpback whales reported in Rone *et al.* (2017). For the Eastern North Pacific stock of gray whales, application of the Phase III BRFs with corresponding cut-offs (20 km for mysticetes) resulted in true zero takes by Level B harassment for Phase III. However, Palacios *et al.* (2021) reported locations of three tagged gray whales within the TMAA as well as tracks of two additional gray whales that crossed the TMAA, and as noted previously, the TMAA overlaps with the gray whale migratory corridor BIA (November–January, southbound; March–May, northbound). As such, NMFS is conservatively proposing to authorize take by Level B harassment of one group (4 animals) of Eastern North Pacific gray whales annually in this Phase III rulemaking. The annual take estimate of 4 animals reflects the average group sizes of on and off-effort survey sightings of gray whales (excluding an outlier of an estimated 25 gray whales in one group) reported in Rone *et al.* (2017).

For all other species and stocks, NMFS agrees that the estimates for incidental takes by harassment from all sources requested for authorization are the maximum number of instances in which marine mammals are reasonably expected to be taken. NMFS also agrees that no mortality or serious injury is anticipated to occur, and no lethal take is proposed to be authorized.

Estimated Harassment Take From Training Activities

For the Navy's training activities, Table 30 summarizes the Navy's take estimate and request and the maximum annual and 7-year total amount and type of Level A harassment and Level B harassment for the 7-year period that NMFS anticipates is reasonably likely to occur (including the incidental take of Western North Pacific stock of humpback whale and Eastern North Pacific stock of gray whale, discussed above) by species and stock. Note that take by Level B harassment includes both behavioral disruption and TTS. Tables 6–10 through 6–24 (sonar and other transducers) and 6–41 through 6–49 (explosives) in Section 6 of the Navy's rulemaking/LOA application provide the comparative amounts of TTS and behavioral disruption for each species and stock annually, noting that if a modeled marine mammal was ''taken'' through exposure to both TTS and behavioral disruption in the model, it was recorded as a TTS.

TABLE 30—ANNUAL AND 7-YEAR TOTAL SPECIES/STOCK-SPECIFIC TAKE ESTIMATES PROPOSED FOR AUTHORIZATION FROM ACOUSTIC AND EXPLOSIVE SOUND SOURCE EFFECTS FOR ALL TRAINING ACTIVITIES IN THE TMAA

Species	Stock	Annual		7-year total	
		Level B	Level A	Level B	Level A
Order Cetacea Suborder Mysticeti (baleen whales)					
Family Balaenidae (right whales):					
North Pacific right whale *	Eastern North Pacific	3	0	21	0
Family Balaenopteridae (rorquals):					
Humpback whale	California, Oregon, & Washington *	10	0	70	0
	Central North Pacific *	79	0	553	0
	Western North Pacific *	[a] 3	0	[a] 21	0
Blue whale *	Central North Pacific	3	0	21	0
	Eastern North Pacific	36	0	252	0
Fin whale *	Northeast Pacific	1,242	2	8,694	14

TABLE 30—ANNUAL AND 7-YEAR TOTAL SPECIES/STOCK-SPECIFIC TAKE ESTIMATES PROPOSED FOR AUTHORIZATION FROM ACOUSTIC AND EXPLOSIVE SOUND SOURCE EFFECTS FOR ALL TRAINING ACTIVITIES IN THE TMAA—Continued

Species	Stock	Annual		7-year total	
		Level B	Level A	Level B	Level A
Sei whale *	Eastern North Pacific	37	0	259	0
Minke whale	Alaska	50	0	350	0
Family Eschrichtiidae (gray whale):					
Gray whale	Eastern North Pacific	[a] 4	0	[a] 28	0
Suborder Odontoceti (toothed whales)					
Family Delphinidae (dolphins):					
Killer whale	Eastern North Pacific, Offshore	81	0	567	0
	Gulf of Alaska, Aleutian Island, & Bering Sea Transient.	143	0	1,001	0
Pacific white-sided dolphin	North Pacific	1,574	0	11,018	0
Family Phocoenidae (porpoises):					
Dall's porpoise	Alaska	9,287	64	65,009	448
Family Physeteridae (sperm whale):					
Sperm whale *	North Pacific	112	0	784	0
Family Ziphiidae (beaked whales):					
Baird's beaked whale	Alaska	106	0	742	0
Cuvier's beaked whale	Alaska	433	0	3,031	0
Stejneger's beaked whale	Alaska	482	0	3,374	0
Order Carnivora Suborder Pinnipedia					
Family Otarridae:					
Northern fur seal	Eastern Pacific	3,003	0	21,021	0
	California	61	0	427	0
Family Phocidae (true seals):					
Northern elephant seal	California	2,547	8	17,829	56

* ESA-listed species and stocks within the GOA Study Area.
[a] The Navy's Acoustic Effects Model estimated zero takes for each of these stocks. However, NMFS conservatively proposes to authorize take by Level B harassment of one group of Western North Pacific humpback whale and one group of Eastern North Pacific gray whale. The annual take estimates reflect the average group sizes of on and off-effort survey sightings of humpback whale and gray whale (excluding an outlier of an estimated 25 gray whales in one group) reported in Rone *et al.* (2017).

Proposed Mitigation Measures

Under section 101(a)(5)(A) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to the activity, and other means of effecting the least practicable adverse impact on the species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for subsistence uses (''least practicable adverse impact''). NMFS does not have a regulatory definition for least practicable adverse impact. The 2004 NDAA amended the MMPA as it relates to military readiness activities and the incidental take authorization process such that a determination of ''least practicable adverse impact'' shall include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

In *Conservation Council for Hawaii* v. *National Marine Fisheries Service,* 97 F. Supp. 3d 1210, 1229 (D. Haw. 2015), the Court stated that NMFS ''appear[s] to think [it] satisf[ies] the statutory 'least practicable adverse impact' requirement with a 'negligible impact' finding.'' In 2016, expressing similar concerns in a challenge to a U.S. Navy Surveillance Towed Array Sensor System Low Frequency Active Sonar (SURTASS LFA) incidental take rule (77 FR 50290), the Ninth Circuit Court of Appeals in *Natural Resources Defense Council (NRDC)* v. *Pritzker,* 828 F.3d 1125, 1134 (9th Cir. 2016), stated ''[c]ompliance with the 'negligible impact' requirement does not mean there [is] compliance with the 'least practicable adverse impact' standard.'' As the Ninth Circuit noted in its opinion, however, the Court was interpreting the statute without the benefit of NMFS' formal interpretation. We state here explicitly that NMFS is in full agreement that the ''negligible impact'' and ''least practicable adverse impact'' requirements are distinct, even though both statutory standards refer to species and stocks. With that in mind, we provide further explanation of our interpretation of least practicable adverse impact, and explain what distinguishes it from the negligible impact standard. This discussion is consistent with previous rules we have published, such as the Navy's HSTT rule (83 FR 66846; December 27, 2018), AFTT rule (84 FR 70712; December 23, 2019), Mariana Islands Training and Testing (MITT) rule (85 FR 46302; July 31, 2020), and the Northwest Training and Testing (NWTT) rule (85 FR 72312; November 12, 2020).

Before NMFS can issue incidental take regulations under section 101(a)(5)(A) of the MMPA, it must make a finding that the total taking will have a ''negligible impact'' on the affected ''species or stocks'' of marine mammals. NMFS' and U.S. Fish and Wildlife Service's implementing regulations for section 101(a)(5) both define ''negligible impact'' 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 (50 CFR 216.103 and 50 CFR 18.27(c)). Recruitment (*i.e.,* reproduction) and survival rates are used to determine population growth rates [2] and, therefore are considered in evaluating population level impacts.

As stated in the preamble to the proposed rule for the MMPA incidental take implementing regulations (53 FR 8473; March 15, 1988), not every population-level impact violates the negligible impact requirement. 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 it requires that no significant effect on annual rates of recruitment or survival occurs. The key factor is the significance of the level of impact on rates of recruitment or survival. (54 FR 40338, 40341–42; September 29, 1989).

While some level of impact on population numbers or growth rates of a species or stock may occur and still satisfy the negligible impact requirement—even without consideration of mitigation—the least practicable adverse impact provision separately requires NMFS to prescribe means of effecting the least practicable adverse impact on the species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance (50 CFR 216.102(b)), which are typically identified as the subject of mitigation measures.[3]

The negligible impact and least practicable adverse impact standards in the MMPA both call for evaluation at the level of the ''species or stock.'' The MMPA does not define the term ''species.'' However, Merriam-Webster Dictionary defines ''species'' to include ''related organisms or *populations* potentially capable of interbreeding.'' See *www.merriam-webster.com/dictionary/species* (emphasis added). Section 3(11) of the MMPA defines ''stock'' as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature. The definition of ''population'' is a group of interbreeding organisms that represents the level of organization at which speciation begins. *www.merriam-webster.com/dictionary/population.* The definition of ''population'' is strikingly similar to the MMPA's definition of ''stock,'' with both involving groups of individuals that belong to the same species and are located in a manner that allows for interbreeding. In fact, under MMPA section 3(11), the statutory term ''stock'' in the MMPA is interchangeable with the statutory term ''population stock.'' Both the negligible impact standard and the least practicable adverse impact standard call for evaluation at the level of the species or stock, and the terms ''species'' and ''stock'' both relate to populations; therefore, it is appropriate to view both the negligible impact standard and the least practicable adverse impact standard as having a population-level focus.

This interpretation is consistent with Congress' statutory findings for enacting the MMPA, nearly all of which are most applicable at the species or stock (*i.e.,* population) level. *See* MMPA section 2 (finding that it is species and population stocks that are or may be in danger of extinction or depletion; that it is species and population stocks that should not diminish beyond being significant functioning elements of their ecosystems; and that it is species and population stocks that should not be permitted to diminish below their optimum sustainable population level). Annual rates of recruitment (*i.e.,* reproduction) and survival are the key biological metrics used in the evaluation of population-level impacts, and accordingly these same metrics are also used in the evaluation of population level impacts for the least practicable adverse impact standard.

Recognizing this common focus of the least practicable adverse impact and negligible impact provisions on the ''species or stock'' does not mean we conflate the two standards; despite some common statutory language, we recognize the two provisions are different and have different functions. First, a negligible impact finding is required before NMFS can issue an incidental take authorization. Although it is acceptable to use the mitigation measures to reach a negligible impact finding (*see* 50 CFR 216.104(c)), no amount of mitigation can enable NMFS to issue an incidental take authorization for an activity that still would not meet the negligible impact standard. Moreover, even where NMFS can reach a negligible impact finding—which we emphasize does allow for the possibility of some ''negligible'' population-level impact—the agency must still prescribe measures that will affect the least practicable amount of adverse impact upon the affected species or stock.

Section 101(a)(5)(A)(i)(II) requires NMFS to issue, in conjunction with its authorization, binding—and enforceable—restrictions (in the form of regulations) setting forth how the activity must be conducted, thus ensuring the activity has the ''least practicable adverse impact'' on the affected species or stocks. In situations where mitigation is specifically needed to reach a negligible impact determination, section 101(a)(5)(A)(i)(II) also provides a mechanism for ensuring compliance with the ''negligible impact'' requirement. Finally, the least practicable adverse impact standard also requires consideration of measures for marine mammal habitat, with particular attention to rookeries, mating grounds, and other areas of similar significance, and for subsistence impacts, whereas the negligible impact standard is concerned solely with conclusions about the impact of an activity on annual rates of recruitment and survival.[4] In *NRDC* v. *Pritzker,* the Court stated, ''[t]he statute is properly read to mean that even if population levels are not threatened *significantly,* still the agency must adopt mitigation measures aimed at protecting *marine mammals* to the greatest extent practicable in light of military readiness needs.'' *Pritzker* at 1134 (emphases added). This statement is consistent with our understanding stated above that even when the effects of an action satisfy the negligible impact standard (*i.e.,* in the Court's words, ''population levels are not threatened significantly''), still the agency must prescribe mitigation under the least practicable adverse impact standard. However, as the statute indicates, the focus of both standards is ultimately the impact on the affected ''species or stock,'' and not solely focused on or directed at the impact on individual marine mammals.

We have carefully reviewed and considered the Ninth Circuit's opinion in *NRDC* v. *Pritzker* in its entirety. While the Court's reference to ''marine mammals'' rather than ''marine mammal species or stocks'' in the italicized language above might be construed as holding that the least practicable adverse impact standard applies at the individual ''marine mammal'' level, *i.e.,* that NMFS must require mitigation to minimize impacts to each individual marine mammal unless impracticable, we believe such an interpretation reflects an incomplete appreciation of the Court's holding. In our view, the opinion as a whole turned on the Court's determination that NMFS had not given separate and independent

[2] A growth rate can be positive, negative, or flat.

[3] Separately, NMFS also must prescribe means of effecting the least practicable adverse impact on the availability of the species or stocks for subsistence uses, when applicable. See the Subsistence Harvest of Marine Mammals section for separate discussion of the effects of the specified activities on Alaska Native subsistence use.

[4] Outside of the military readiness context, mitigation may also be appropriate to ensure compliance with the ''small numbers'' language in MMPA sections 101(a)(5)(A) and (D).

meaning to the least practicable adverse impact standard apart from the negligible impact standard, and further, that the Court's use of the term ''marine mammals'' was not addressing the question of whether the standard applies to individual animals as opposed to the species or stock as a whole. We recognize that, while consideration of mitigation can play a role in a negligible impact determination, consideration of mitigation measures extends beyond that analysis. In evaluating what mitigation measures are appropriate, NMFS considers the potential impacts of the specified activities, the availability of measures to minimize those potential impacts, and the practicability of implementing those measures, as we describe below.

Implementation of Least Practicable Adverse Impact Standard

Given the *NRDC* v. *Pritzker* decision, we discuss here how we determine whether a measure or set of measures meets the ''least practicable adverse impact'' standard. Our separate analysis of whether the take anticipated to result from Navy's activities meets the ''negligible impact'' standard appears in the Preliminary Analysis and Negligible Impact Determination section below.

Our evaluation of potential mitigation measures includes consideration of two primary factors:

(1) The manner in which, and the degree to which, implementation of the potential measure(s) is expected to reduce adverse impacts to marine mammal species or stocks, their habitat, or their availability for subsistence uses (where relevant). This analysis considers such things as the nature of the potential adverse impact (such as likelihood, scope, and range), the likelihood that the measure will be effective if implemented, and the likelihood of successful implementation; and

(2) The practicability of the measure(s) for applicant implementation. Practicability of implementation may consider such things as cost, impact on activities, and, in the case of a military readiness activity, specifically considers personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

While the language of the least practicable adverse impact standard calls for minimizing impacts to affected species or stocks, we recognize that the reduction of impacts to those species or stocks accrues through the application of mitigation measures that limit impacts to individual animals. Accordingly, NMFS' analysis focuses on measures that are designed to avoid or minimize impacts on individual marine mammals that are likely to increase the probability or severity of population-level effects.

While direct evidence of impacts to species or stocks from a specified activity is rarely available, and additional study is still needed to understand how specific disturbance events affect the fitness of individuals of certain species, there have been improvements in understanding the process by which disturbance effects are translated to the population. With recent scientific advancements (both marine mammal energetic research and the development of energetic frameworks), the relative likelihood or degree of impacts on species or stocks may often be inferred given a detailed understanding of the activity, the environment, and the affected species or stocks—and the best available science has been used here. This same information is used in the development of mitigation measures and helps us understand how mitigation measures contribute to lessening effects (or the risk thereof) to species or stocks. We also acknowledge that there is always the potential that new information, or a new recommendation, could become available in the future and necessitate reevaluation of mitigation measures (which may be addressed through adaptive management) to see if further reductions of population impacts are possible and practicable.

In the evaluation of specific measures, the details of the specified activity will necessarily inform each of the two primary factors discussed above (expected reduction of impacts and practicability), and are carefully considered to determine the types of mitigation that are appropriate under the least practicable adverse impact standard. Analysis of how a potential mitigation measure may reduce adverse impacts on a marine mammal stock or species, consideration of personnel safety, practicality of implementation, and consideration of the impact on effectiveness of military readiness activities are not issues that can be meaningfully evaluated through a yes/no lens. The manner in which, and the degree to which, implementation of a measure is expected to reduce impacts, as well as its practicability in terms of these considerations, can vary widely. For example, a time/area restriction could be of very high value for decreasing population-level impacts (*e.g.,* avoiding disturbance of feeding females in an area of established biological importance) or it could be of lower value (*e.g.,* decreased disturbance in an area of high productivity but of less biological importance). Regarding practicability, a measure might involve restrictions in an area or time that impede the Navy's ability to certify a strike group (higher impact on mission effectiveness), or it could mean delaying a small in-port training event by 30 minutes to avoid exposure of a marine mammal to injurious levels of sound (lower impact). A responsible evaluation of ''least practicable adverse impact'' will consider the factors along these realistic scales. Accordingly, the greater the likelihood that a measure will contribute to reducing the probability or severity of adverse impacts to the species or stock or its habitat, the greater the weight that measure is given when considered in combination with practicability to determine the appropriateness of the mitigation measure, and vice versa. We discuss consideration of these factors in greater detail below.

1. *Reduction of adverse impacts to marine mammal species or stocks and their habitat.* The emphasis given to a measure's ability to reduce the impacts on a species or stock considers the degree, likelihood, and context of the anticipated reduction of impacts to individuals (and how many individuals) as well as the status of the species or stock.

The ultimate impact on any individual from a disturbance event (which informs the likelihood of adverse species- or stock-level effects) is dependent on the circumstances and associated contextual factors, such as duration of exposure to stressors. Though any proposed mitigation needs to be evaluated in the context of the specific activity and the species or stocks affected, measures with the following types of effects have greater value in reducing the likelihood or severity of adverse species- or stock-level impacts: avoiding or minimizing injury or mortality; limiting interruption of known feeding, breeding, mother/young, or resting behaviors; minimizing the abandonment of important habitat (temporally and spatially); minimizing the number of individuals subjected to these types of disruptions; and limiting degradation of habitat. Mitigating these types of effects is intended to reduce the likelihood that the activity will result in energetic or other types of impacts that are more likely to result in reduced reproductive success or survivorship. It is also important to consider the degree of impacts that are expected in the absence of mitigation in order to assess the added value of any potential measures. Finally, because the least practicable adverse impact standard gives NMFS discretion to weigh a variety of factors when determining appropriate mitigation measures and because the focus of the standard is on reducing impacts at the species or stock level, the least practicable adverse impact standard does not compel mitigation for every kind of take, or every individual taken, if that mitigation is unlikely to meaningfully contribute to the reduction of adverse impacts on the species or stock and its habitat, even when practicable for implementation by the applicant.

The status of the species or stock is also relevant in evaluating the appropriateness of potential mitigation measures in the context of least practicable adverse impact. The following are examples of factors that may (either alone, or in combination) result in greater emphasis on the importance of a mitigation measure in reducing impacts on a species or stock: the stock is known to be decreasing or status is unknown, but believed to be declining; the known annual mortality (from any source) is approaching or exceeding the potential biological removal (PBR) level (as defined in MMPA section 3(20)); the affected species or stock is a small, resident population; or the stock is involved in a UME or has other known vulnerabilities, such as recovering from an oil spill.

Habitat mitigation, particularly as it relates to rookeries, mating grounds, and areas of similar significance, is also relevant to achieving the standard and can include measures such as reducing impacts of the activity on known prey utilized in the activity area or reducing impacts on physical habitat. As with species- or stock-related mitigation, the emphasis given to a measure's ability to reduce impacts on a species or stock's habitat considers the degree, likelihood, and context of the anticipated reduction of impacts to habitat. Because habitat value is informed by marine mammal presence and use, in some cases there may be overlap in measures for the species or stock and for use of habitat.

We consider available information indicating the likelihood of any measure to accomplish its objective. If evidence shows that a measure has not typically been effective nor successful, then either that measure should be modified or the potential value of the measure to reduce effects should be lowered.

2. *Practicability.* Factors considered may include cost, impact on activities, and, in the case of a military readiness activity, will include personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity (see MMPA section 101(a)(5)(A)(ii)).

Assessment of Mitigation Measures for the GOA Study Area

NMFS has fully reviewed the specified activities and the mitigation measures included in the Navy's rulemaking/LOA application, the 2020 GOA DSEIS/OEIS, and the 2022 Supplement to the 2020 GOA DSEIS/OEIS to determine if the mitigation measures would result in the least practicable adverse impact on marine mammals and their habitat. NMFS worked with the Navy in the development of the Navy's initially proposed measures, which are informed by years of implementation and monitoring. A complete discussion of the Navy's evaluation process used to develop, assess, and select mitigation measures, which was informed by input from NMFS, can be found in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS. The process described in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS robustly supported NMFS' independent evaluation of whether the mitigation measures would meet the least practicable adverse impact standard, including the addition of the Continental Shelf and Slope Mitigation Area presented in the February 2022 second updated application and analyzed in the 2022 Supplement to the 2020 GOA DSEIS/OEIS. The Navy would be required to implement the mitigation measures identified in this rule for the full 7 years to avoid or reduce potential impacts from acoustic and explosive stressors.

As a general matter, where an applicant proposes measures that are likely to reduce impacts to marine mammals, the fact that they are included in the application indicates that the measures are practicable, and it is not necessary for NMFS to conduct a detailed analysis of the measures the applicant proposed (rather, they are simply included). However, it is still necessary for NMFS to consider whether there are additional practicable measures that would meaningfully reduce the probability or severity of impacts that could affect reproductive success or survivorship.

Overall the Navy has agreed to procedural mitigation measures that would reduce the probability and/or severity of impacts expected to result from acute exposure to acoustic sources or explosives, ship strike, and impacts to marine mammal habitat. Specifically, the Navy would use a combination of delayed starts, powerdowns, and shutdowns to avoid mortality or serious injury, minimize the likelihood or severity of PTS or other injury, and reduce instances of TTS or more severe behavioral disruption caused by acoustic sources or explosives. The Navy would also implement multiple time/area restrictions that would reduce take of marine mammals in areas or at times where they are known to engage in important behaviors, such as foraging, where the disruption of those behaviors would have a higher probability of resulting in impacts on reproduction or survival of individuals that could lead to population-level impacts.

The Navy assessed the practicability of the proposed measures in the context of personnel safety, practicality of implementation, and their impacts on the Navy's ability to meet their Title 10 requirements and found that the measures are supportable. As described in more detail below, NMFS has independently evaluated the measures the Navy proposed in the manner described earlier in this section (*i.e.,* in consideration of their ability to reduce adverse impacts on marine mammal species and their habitat and their practicability for implementation). We have determined that the measures would significantly and adequately reduce impacts on the affected marine mammal species and stocks and their habitat and, further, be practicable for Navy implementation. Therefore, the mitigation measures assure that the Navy's activities would have the least practicable adverse impact on the species or stocks and their habitat.

The Navy also evaluated numerous measures in the 2020 GOA DSEIS/OEIS that were not included in the Navy's rulemaking/LOA application, and NMFS independently reviewed and preliminarily concurs with the Navy's analysis that their inclusion was not appropriate under the least practicable adverse impact standard based on our assessment. The Navy considered these additional potential mitigation measures in two groups. First, Chapter 5 (*Mitigation)* of the 2020 GOA DSEIS/OEIS, in the *Measures Considered but Eliminated* section, includes an analysis of an array of different types of mitigation that have been recommended over the years by non-governmental organizations or the public, through scoping or public comment on environmental compliance documents. As described in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS, the Navy considered reducing its overall amount of training, reducing explosive use, modifying its sound sources, completely replacing live training with computer simulation, and including time of day restrictions. Many of these mitigation measures could potentially reduce the number of marine mammals taken, via direct reduction of the activities or amount of sound energy put in the water. However, as described in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS, the Navy needs to train in the conditions in which it fights—and these types of modifications fundamentally change the activity in a manner that would not support the purpose and need for the training (*i.e.,* are entirely impracticable) and therefore are not considered further. NMFS finds the Navy's explanation for why adoption of these recommendations would unacceptably undermine the purpose of the training persuasive. After independent review, NMFS finds the Navy's judgment on the impacts of these potential mitigation measures to personnel safety, practicality of implementation, and the effectiveness of training persuasive, and for these reasons, NMFS finds that these measures do not meet the least practicable adverse impact standard because they are not practicable for implementation in either the TMAA or the GOA Study Area overall.

Second, in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS, the Navy evaluated additional potential procedural mitigation measures, including increased mitigation zones, ramp-up measures, additional passive acoustic and visual monitoring, and decreased vessel speeds. Some of these measures have the potential to incrementally reduce take to some degree in certain circumstances, though the degree to which this would occur is typically low or uncertain. However, as described in the Navy's analysis, the measures would have significant direct negative effects on mission effectiveness and are considered impracticable (see Chapter 5, *Mitigation,* of 2020 GOA DSEIS/OEIS). NMFS independently reviewed the Navy's evaluation and concurs with this assessment, which supports NMFS' preliminary findings that the impracticability of this additional mitigation would greatly outweigh any potential minor reduction in marine mammal impacts that might result; therefore, these additional mitigation measures are not warranted.

Last, Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS, also describes a comprehensive analysis of potential geographic mitigation that includes consideration of both a biological assessment of how the potential time/area limitation would benefit the species and its habitat (*e.g.,* is a key area of biological importance or would result in avoidance or reduction of impacts) in the context of the stressors of concern in the specific area and an operational assessment of the practicability of implementation (*e.g.,* including an assessment of the specific importance of an area for training, considering proximity to training ranges and emergency landing fields and other issues). In its second updated application and the 2022 Supplement to the 2020 GOA DSEIS/OEIS, the Navy included an expansion to the mitigation area previously referred to as the Portlock Bank Mitigation Area, now referred to as the Continental Shelf and Slope Mitigation Area. The Navy has found that geographic mitigation beyond what is included in the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS is not warranted because the anticipated reduction of adverse impacts on marine mammal species and their habitat is not sufficient to offset the impracticability of implementation. In some cases potential benefits to marine mammals were non-existent, while in others the consequences on mission effectiveness were too great.

NMFS has reviewed the Navy's analysis in Chapter 5 (*Mitigation*) of the 2020 GOA DSEIS/OEIS and Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) of the 2022 Supplement to the 2020 GOA DSEIS/OEIS, which consider the same factors that NMFS considers to satisfy the least practicable adverse impact standard, and concurs with the analysis and conclusions. Therefore, NMFS is not proposing to include any of the measures that the Navy ruled out in the 2020 GOA DSEIS/OEIS. Below are the mitigation measures that NMFS has preliminarily determined would ensure the least practicable adverse impact on all affected species and their habitat, including the specific considerations for military readiness activities. The following sections describe the mitigation measures that would be implemented in association with the training activities analyzed in this document. The mitigation measures are organized into two categories: procedural mitigation and mitigation areas.

Procedural Mitigation

Procedural mitigation is mitigation that the Navy would implement whenever and wherever an applicable training activity takes place within the GOA Study Area. The Navy customizes procedural mitigation for each applicable activity category or stressor. Procedural mitigation generally involves: (1) the use of one or more trained Lookouts to diligently observe for specific biological resources (including marine mammals) within a mitigation zone, (2) requirements for Lookouts to immediately communicate sightings of specific biological resources to the appropriate watch station for information dissemination, and (3) requirements for the watch station to implement mitigation (*e.g.,* halt an activity) until certain recommencement conditions have been met. The first procedural mitigation (Table 31) is designed to aid Lookouts and other applicable Navy personnel with their observation, environmental compliance, and reporting responsibilities. The remainder of the procedural mitigation measures (Table 32 through Table 39) are organized by stressor type and activity category and include acoustic stressors (*i.e.,* active sonar, weapons firing noise), explosive stressors (*i.e.,* large-caliber projectiles, bombs), and physical disturbance and strike stressors (*i.e.,* vessel movement, towed in-water devices, small-, medium-, and large-caliber non-explosive practice munitions, non-explosive bombs).

TABLE 31—PROCEDURAL MITIGATION FOR ENVIRONMENTAL AWARENESS AND EDUCATION

Procedural mitigation description
Stressor or Activity: • All training activities, as applicable. *Mitigation Requirements:* • Appropriate Navy personnel (including civilian personnel) involved in mitigation and training activity reporting under the specified activities will complete one or more modules of the U.S. Navy Afloat Environmental Compliance Training Series, as identified in their career path training plan. Modules include:

TABLE 31—PROCEDURAL MITIGATION FOR ENVIRONMENTAL AWARENESS AND EDUCATION—Continued

Procedural mitigation description
—Introduction to the U.S. Navy Afloat Environmental Compliance Training Series. The introductory module provides information on environmental laws (*e.g.,* Endangered Species Act, Marine Mammal Protection Act) and the corresponding responsibilities that are relevant to Navy training activities. The material explains why environmental compliance is important in supporting the Navy's commitment to environmental stewardship. —Marine Species Awareness Training. All bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare aircrews, Lookouts, and equivalent civilian personnel must successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures. Navy biologists developed Marine Species Awareness Training to improve the effectiveness of visual observations for biological resources, focusing on marine mammals and sea turtles, and including floating vegetation, jellyfish aggregations, and flocks of seabirds. —U.S. Navy Protective Measures Assessment Protocol. This module provides the necessary instruction for accessing mitigation requirements during the event planning phase using the Protective Measures Assessment Protocol software tool. —U.S. Navy Sonar Positional Reporting System and Marine Mammal Incident Reporting. This module provides instruction on the procedures and activity reporting requirements for the Sonar Positional Reporting System and marine mammal incident reporting.

Procedural Mitigation for Acoustic Stressors

Mitigation measures for acoustic stressors are provided in Table 32 and Table 33.

TABLE 32—PROCEDURAL MITIGATION FOR ACTIVE SONAR

Procedural mitigation description
Stressor or Activity: • Mid-frequency active sonar and high-frequency active sonar: —For vessel-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned surface vessels (*e.g.,* sonar sources towed from manned surface platforms). —For aircraft-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned aircraft that do not operate at high altitudes (*e.g.,* rotary-wing aircraft). Mitigation does not apply to active sonar sources deployed from unmanned aircraft or aircraft operating at high altitudes (*e.g.,* maritime patrol aircraft). *Number of Lookouts and Observation Platform:* • Hull-mounted sources: —1 Lookout: Platforms with space or manning restrictions while underway (at the forward part of a small boat or ship) and platforms using active sonar while moored or at anchor. —2 Lookouts: Platforms without space or manning restrictions while underway (at the forward part of the ship). • Sources that are not hull-mounted: —1 Lookout on the ship or aircraft conducting the activity. *Mitigation Requirements:* • Mitigation zones: —1,000 yd (914.4 m) power down, 500 yd (457.2 m) power down, and 200 yd (182.9 m) shut down for hull-mounted mid-frequency active sonar (see *During the activity* below). —200 yd (182.9 m) shut down for mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar (see *During the activity* below). • Prior to the initial start of the activity (*e.g.,* when maneuvering on station): —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of active sonar transmission until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity: —Hull-mounted mid-frequency active sonar: Navy personnel will observe the mitigation zone for marine mammals; Navy personnel will power down active sonar transmission by 6 dB if a marine mammal is observed within 1,000 yd (914.4 m) of the sonar source; Navy personnel will power down active sonar transmission an additional 4 dB (10 dB total) if a marine mammal is observed within 500 yd (457.2 m) of the sonar source; Navy personnel will cease transmission if a marine mammal is observed within 200 yd (182.9 m) of the sonar source. —Mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar: Navy personnel will observe the mitigation zone for marine mammals; Navy personnel will cease transmission if a marine mammal is observed within 200 yd (182.9 m) of the sonar source. • Commencement/recommencement conditions after a marine mammal sighting before or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing or powering up active sonar transmission) until one of the following conditions has been 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, speed, and movement relative to the sonar source; (3) the mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-deployed sonar sources or 30 minutes for vessel-deployed sonar sources; (4) for mobile activities, the active sonar source has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or (5) for activities using hull-mounted sonar, the Lookout concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave, and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone).

TABLE 33—PROCEDURAL MITIGATION FOR WEAPONS FIRING NOISE

Procedural mitigation description
Stressor or Activity: • Weapon firing noise associated with large-caliber gunnery activities. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned on the ship conducting the firing —Depending on the activity, the Lookout could be the same one described in Procedural Mitigation for Explosive Large-Caliber Projectiles (Table 34) or Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions (Table 38). *Mitigation Requirements:* • Mitigation zone: —30° on either side of the firing line out to 70 yd (64 m) from the muzzle of the weapon being fired. • Prior to the initial start of the activity: —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of weapon firing until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity: —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will cease weapon firing. • Commencement/recommencement conditions after a marine mammal sighting before or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing weapon firing) until one of the following conditions has been 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, speed, and movement relative to the firing ship; (3) the mitigation zone has been clear from any additional sightings for 30 minutes; or (4) for mobile activities, the firing ship has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Procedural Mitigation for Explosive Stressors

Mitigation measures for explosive stressors are provided in Table 34 and Table 35.

TABLE 34—PROCEDURAL MITIGATION FOR EXPLOSIVE LARGE-CALIBER PROJECTILES

Procedural mitigation description
Stressor or Activity: • Gunnery activities using explosive large-caliber projectiles. —Mitigation applies to activities using a surface target. *Number of Lookouts and Observation Platform:* • 1 Lookout on the vessel or aircraft conducting the activity. —Depending on the activity, the Lookout could be the same as the one described for Procedural Mitigation for Weapons Firing Noise in Table 33. • If additional platforms are participating in the activity, Navy personnel positioned in those assets (*e.g.,* safety observers, evaluators) will support observing the mitigation zone for marine mammals while performing their regular duties. *Mitigation Requirements:* • Mitigation zones: —1,000 yd (914.4 m) around the intended impact location. • Prior to the initial start of the activity (*e.g.,* when maneuvering on station): —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of firing until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity: —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will cease firing. • Commencement/recommencement conditions after a marine mammal sighting before or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 30 minutes; or (4) for activities using mobile targets, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting. • After completion of the activity (*e.g.,* prior to maneuvering off station): —Navy personnel will, when practical (*e.g.,* when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe the vicinity of where detonations occurred; if any injured or dead marine mammals are observed, Navy personnel will follow established incident reporting procedures. —If additional platforms are supporting this activity (*e.g.,* providing range clearance), Navy personnel positioned on these assets will assist in the visual observation of the area where detonations occurred.

TABLE 35—PROCEDURAL MITIGATION FOR EXPLOSIVE BOMBS

Procedural mitigation description
Stressor or Activity: • Explosive bombs. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in the aircraft conducting the activity. • If additional platforms are participating in the activity, Navy personnel positioned in those assets (*e.g.,* safety observers, evaluators) will support observing the mitigation zone for marine mammals while performing their regular duties. *Mitigation Requirements:* • Mitigation zone: —2,500 yd (2,286 m) around the intended target. • Prior to the initial start of the activity (*e.g.,* when arriving on station): —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of bomb deployment until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity (*e.g.,* during target approach): —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will cease bomb deployment. • Commencement/recommencement conditions after a marine mammal sighting before or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment) until one of the following conditions has been 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, speed, and movement relative to the intended target; (3) the mitigation zone has been clear from any additional sightings for 10 minutes; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting. • After completion of the activity (*e.g.,* prior to maneuvering off station): —Navy personnel will, when practical (*e.g.,* when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe for marine mammals in the vicinity of where detonations occurred; if any injured or dead marine mammals are observed, Navy personnel will follow established incident reporting procedures. —If additional platforms are supporting this activity (*e.g.,* providing range clearance), Navy personnel positioned on these assets will assist in the visual observation of the area where detonations occurred.

Procedural Mitigation for Physical Disturbance and Strike Stressors

Mitigation measures for physical disturbance and strike stressors are provided in Table 36 through Table 39.

TABLE 36—PROCEDURAL MITIGATION FOR VESSEL MOVEMENT

Procedural Mitigation Description
Stressor or Activity: • Vessel movement —The mitigation will not be applied if (1) the vessel's safety is threatened, (2) the vessel is restricted in its ability to maneuver (*e.g.,* during launching and recovery of aircraft or landing craft, during towing activities, when mooring), (3) the vessel is submerged or operated autonomously, or (4) when impractical based on mission requirements (*e.g.,* during Vessel Visit, Board, Search, and Seizure activities as military personnel from ships or aircraft board suspect vessels). *Number of Lookouts and Observation Platform:* • 1 or more Lookouts on the underway vessel • If additional watch personnel are positioned on underway vessels, those personnel (*e.g.,* persons assisting with navigation or safety) will support observing for marine mammals while performing their regular duties. *Mitigation Requirements:* • Mitigation zones: —500 yd (457.2 m) around the vessel for whales. —200 yd (182.9 m) around the vessel for marine mammals other than whales (except those intentionally swimming alongside or closing in to swim alongside vessels, such as bow-riding or wake-riding dolphins). • When Underway: —Navy personnel will observe the direct path of the vessel and waters surrounding the vessel for marine mammals. —If a marine mammal is observed in the direct path of the vessel, Navy personnel will maneuver the vessel as necessary to maintain the appropriate mitigation zone distance. —If a marine mammal is observed within waters surrounding the vessel, Navy personnel will maintain situational awareness of that animal's position. Based on the animal's course and speed relative to the vessel's path, Navy personnel will maneuver the vessel as necessary to ensure that the appropriate mitigation zone distance from the animal continues to be maintained. • Additional requirements: —If a marine mammal vessel strike occurs, Navy personnel will follow established incident reporting procedures.

TABLE 37—PROCEDURAL MITIGATION FOR TOWED IN-WATER DEVICES

Procedural mitigation description
Stressor or Activity: • Towed in-water devices —Mitigation applies to devices that are towed from a manned surface platform or manned aircraft, or when a manned support craft is already participating in an activity involving in-water devices being towed by unmanned platforms. —The mitigation will not be applied if the safety of the towing platform or in-water device is threatened. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned on the towing platform or support craft. *Mitigation Requirements:* • Mitigation zones: —250 yd (228.6 m) around the towed in-water device for marine mammals (except those intentionally swimming alongside or choosing to swim alongside towing vessels, such as bow-riding or wake-riding dolphins) • During the activity (*i.e.,* when towing an in-water device) —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will maneuver to maintain distance.

TABLE 38—PROCEDURAL MITIGATION FOR SMALL-, MEDIUM-, AND LARGE-CALIBER NON-EXPLOSIVE PRACTICE MUNITIONS

Procedural mitigation description
Stressor or Activity: • Gunnery activities using small-, medium-, and large-caliber non-explosive practice munitions —Mitigation applies to activities using a surface target. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned on the platform conducting the activity. —Depending on the activity, the Lookout could be the same as the one described in Procedural Mitigation for Weapons Firing Noise (Table 33). *Mitigation Requirements:* • Mitigation zone: —200 yd (182.9 m) around the intended impact location • Prior to the initial start of the activity (*e.g.,* when maneuvering on station): —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of firing until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity: —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will cease firing. • Commencement/recommencement conditions after a marine mammal, sighting before or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been 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, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-based firing or 30 minutes for vessel-based firing; or (4) for activities using a mobile target, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

TABLE 39—PROCEDURAL MITIGATION FOR NON-EXPLOSIVE BOMBS

Procedural mitigation description
Stressor or Activity: • Non-explosive bombs. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in an aircraft. *Mitigation Requirements:* • Mitigation zone: —1,000 yd (914.4 m) around the intended target. • Prior to the initial start of the activity (*e.g.,* when arriving on station): —Navy personnel will observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel will relocate or delay the start of bomb deployment until the mitigation zone is clear of floating vegetation or the *Commencement/recommencement* conditions in this table are met for marine mammals. • During the activity (*e.g.,* during approach of the target): —Navy personnel will observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel will cease bomb deployment. • Commencement/recommencement conditions after a marine mammal sighting prior to or during the activity: —Navy personnel will allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment) until one of the following conditions has been 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, speed, and movement relative to the intended target; (3) the mitigation zone has been clear from any additional sightings for 10 minutes; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Mitigation Areas

In addition to procedural mitigation, the Navy would implement mitigation measures within mitigation areas to avoid or minimize potential impacts on marine mammals. The Navy took into account the best available science and the practicability of implementing additional mitigation measures, and has enhanced its mitigation measures beyond those that were included in the 2017–2022 regulations to further reduce impacts to marine mammals.

Information on the mitigation measures that the Navy would implement within mitigation areas is provided in Table 40 (see below).

NMFS conducted an independent analysis of the mitigation areas that the Navy proposed, which are described below. NMFS preliminarily concurs with the Navy's analysis, which indicates that the measures in these mitigation areas are both practicable and would reduce the likelihood or severity of adverse impacts to marine mammal species or their habitat in the manner described in the Navy's analysis and this rule. NMFS is heavily reliant on the Navy's description of operational practicability, since the Navy is best equipped to describe the degree to which a given mitigation measure affects personnel safety or mission effectiveness, and is practical to implement. The Navy considers the measures in this proposed rule to be practicable, and NMFS concurs. We further discuss the manner in which the Geographic Mitigation Areas in the proposed rule would reduce the likelihood or severity of adverse impacts to marine mammal species or their habitat in the Preliminary Analysis and Negligible Impact Determination section.

TABLE 40—GEOGRAPHIC MITIGATION AREAS FOR MARINE MAMMALS IN THE GOA STUDY AREA

Mitigation area description
Stressor or Activity: • Sonar. • Explosives. • Physical disturbance and strikes. *Mitigation Requirements:* [1] • North Pacific Right Whale Mitigation Area. —From June 1–September 30 within the North Pacific Right Whale Mitigation Area, Navy personnel will not use surface ship hull-mounted MF1 mid-frequency active sonar during training. • Continental Shelf and Slope Mitigation Area. —Navy personnel will not detonate explosives below 10,000 ft. altitude (including at the water surface) in the Continental Shelf and Slope Mitigation Area during training. • Pre-event Awareness Notifications in the Temporary Maritime Activities Area. —The Navy will issue pre-event awareness messages to alert vessels and aircraft participating in training activities within the TMAA to the possible presence of concentrations of large whales on the continental shelf and slope. Occurrences of large whales may be higher over the continental shelf and slope relative to other areas of the TMAA. Large whale species in the TMAA include, but are not limited to, fin whale, blue whale, humpback whale, gray whale, North Pacific right whale, sei whale, and sperm whale. To maintain safety of navigation and to avoid interactions with marine mammals, the Navy will instruct personnel to remain vigilant to the presence of large whales that may be vulnerable to vessel strikes or potential impacts from training activities. Additionally, Navy personnel will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training activities and to aid in the implementation of procedural mitigation.

[1] Should national security present a requirement to conduct training prohibited by the mitigation requirements specified in this table, naval units will obtain permission from the designated Command, U.S. Third Fleet Command Authority, prior to commencement of the activity. The Navy will provide NMFS with advance notification and include relevant information about the event (*e.g.,* sonar hours, use of explosives detonated below 10,000 ft altitude (including at the water surface) in its annual activity reports to NMFS.

BILLING CODE 3510–22–P

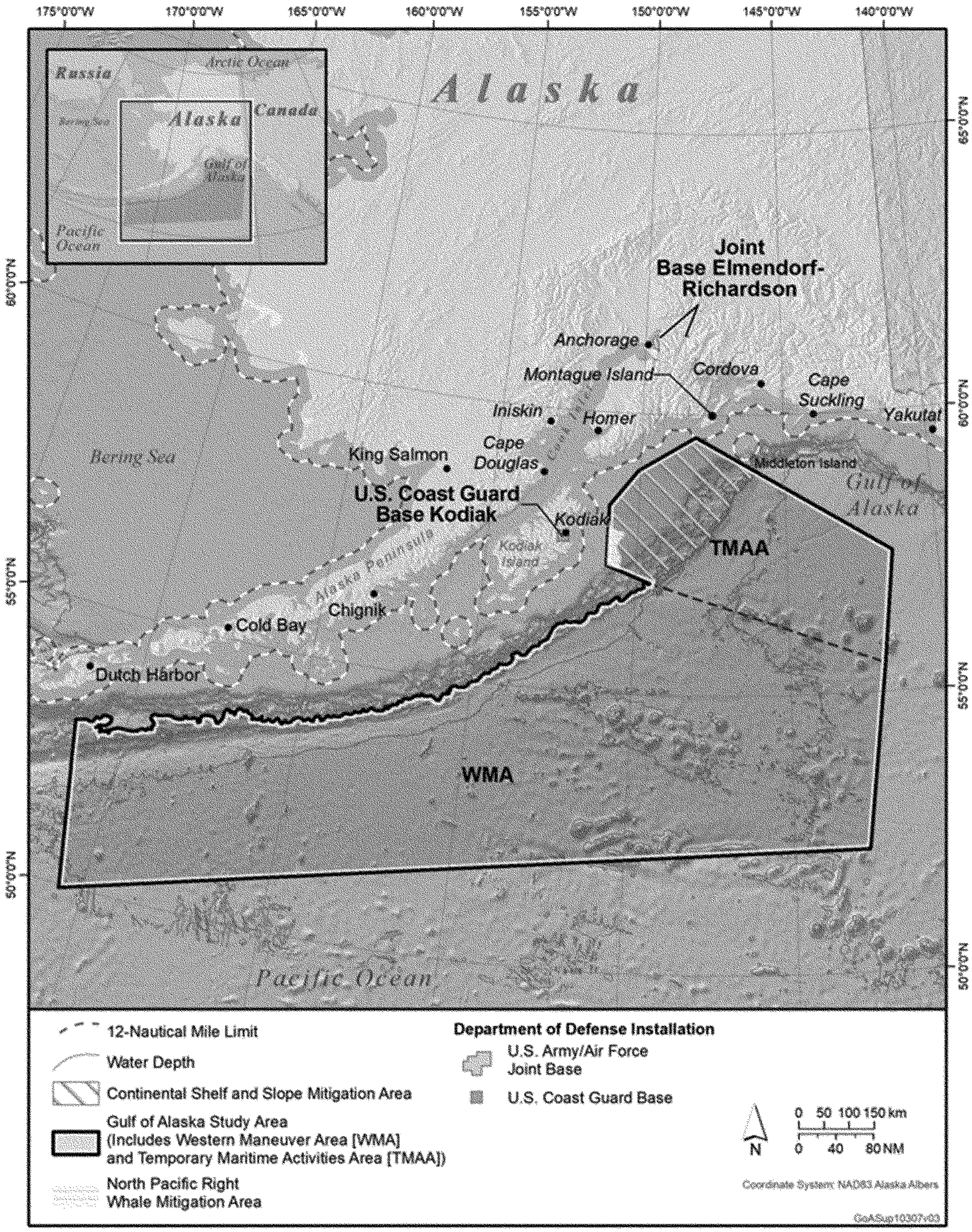

Figure 2-- Geographic Mitigation Areas for Marine Mammals in the GOA Study Area

BILLING CODE 3510–22–C

North Pacific Right Whale Mitigation Area

Mitigation within the North Pacific Right Whale Mitigation Area is primarily designed to avoid or further reduce potential impacts to North Pacific right whales within important feeding habitat. The mitigation area fully encompasses the portion of the BIA identified by Ferguson *et al.* (2015) for North Pacific right whale feeding that overlaps the GOA Study Area (overlap between the GOA Study Area and the BIA occurs in the TMAA only) (Figure 2). North Pacific right whales are thought to occur in the highest densities in the BIA from June to September. The Navy would not use surface ship hull-mounted MF1 mid-frequency active sonar in the mitigation area from June 1 to September 30, as was also required in the Phase II (2017–2022) rule. The North Pacific Right Whale Mitigation Area is fully within the boundary of the Continental Shelf and Slope Mitigation Area, discussed below. Therefore, the mitigation requirements in that area also apply to the North Pacific Right Whale

Mitigation Area. While the potential occurrence of North Pacific right whales in the GOA Study Area is expected to be rare due to the species' extremely low population, these mitigation requirements would help further avoid or further reduce the potential for impacts to occur within North Pacific right whale feeding habitat, thus likely reducing the number of takes of North Pacific right whales, as well as the severity of any disturbances by reducing the likelihood that feeding is interrupted, delayed, or precluded for some limited amount of time.

Additionally, the North Pacific Right Whale Mitigation Area overlaps with a small portion of the humpback whale critical habitat Unit 5, in the southwest corner of the TMAA. While the overlap of the two areas is limited, mitigation in the North Pacific Right Whale Mitigation Area may reduce the number and/or severity of takes of humpback whales in this important area.

The mitigation in this area would also help avoid or reduce potential impacts on fish and invertebrates that inhabit the mitigation area and which marine mammals prey upon. As described in Section 5.4.1.5 (Fisheries Habitats) of the 2020 GOA DSEIS/OEIS, the productive waters off Kodiak Island support a strong trophic system from plankton, invertebrates, small fish, and higher-level predators, including large fish and marine mammals.

Continental Shelf and Slope Mitigation Area

The Continental Shelf and Slope Mitigation Area encompasses the portion of the continental shelf and slope that overlaps the TMAA (the entire continental shelf and slope out to the 4,000 m depth contour; Figure 2). The Navy would not detonate explosives below 10,000 ft. altitude (including at the water surface) in the Continental Shelf and Slope Mitigation Area during training. (As stated previously, the Navy does not plan to use in-water explosives anywhere in the GOA Study Area.) Mitigation in the Continental Shelf and Slope Mitigation Area was initially designed to avoid or reduce potential impacts on fishery resources for Alaska Natives. However, the area includes highly productive waters where marine mammals, including humpback whales (Lagerquist *et al.* 2008) and North Pacific right whales, feed, and overlaps with a small portion of the North Pacific right whale feeding BIA off of Kodiak Island. Additionally, the Continental Shelf and Slope Mitigation Area overlaps with a very small portion of the humpback whale critical habitat Unit 5, on the western side of the TMAA, and a small portion of humpback whale critical habitat Unit 8 on the north side of the TMAA. The Continental Shelf and Slope mitigation area also overlaps with a very small portion of the gray whale migration BIA. The remainder of the designated critical habitat and BIAs are located beyond the boundaries of the GOA Study Area. While the overlap of the mitigation area with critical habitat and feeding and migratory BIAs is limited, mitigation in the Continental Shelf and Slope Mitigation Area may reduce the probability, number, and/or severity of takes of humpback whales, North Pacific right whales, and gray whales in this important area (noting that no takes are predicted for gray whales). Additionally, mitigation in this area will likely reduce the number and severity of potential impacts to marine mammals in general, by reducing the likelihood that feeding is interrupted, delayed, or precluded for some limited amount of time.

Pre-Event Awareness Notifications in the Temporary Maritime Activities Area

The Navy will issue awareness messages prior to the start of TMAA training activities to alert vessels and aircraft operating within the TMAA to the possible presence of concentrations of large whales, including but not limited to, fin whale, blue whale, humpback whale, gray whales, North Pacific right whale, sei whale, minke whale, and sperm whale, especially when traversing on the continental shelf and slope where densities of these species may be higher. To maintain safety of navigation and to avoid interactions with marine mammals, the Navy will instruct vessels to remain vigilant to the presence of large whales that may be vulnerable to vessel strikes or potential impacts from training activities. Navy personnel will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training activities and to aid in the implementation of procedural mitigation.

This mitigation would help avoid or further reduce any potential impacts from vessel strikes and training activities on large whales within the TMAA.

Availability for Subsistence Uses

The nature of subsistence activities by Alaska Natives in the GOA Study Area are discussed below, in the Subsistence Harvest of Marine Mammals section of this proposed rule.

Mitigation Conclusions

NMFS has carefully evaluated the Navy's proposed mitigation measures—many of which were developed with NMFS' input during the previous phases of Navy training authorizations but several of which are new since implementation of the 2017 to 2022 regulations—and considered a broad range of other measures (*i.e.,* the measures considered but eliminated in the 2020 GOA DSEIS/OEIS, which reflect many of the comments that have arisen from public input or through discussion with NMFS in past years) in the context of ensuring that NMFS prescribes the means of effecting the least practicable adverse impact on the affected marine mammal species 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 their habitat; the proven or likely efficacy of the measures; and the practicability of the 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 the Navy and NMFS, NMFS has preliminarily determined that these proposed mitigation measures are appropriate means of effecting the least practicable adverse impact on marine mammal species and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and considering specifically personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity. Additionally, an adaptive management component helps further ensure that mitigation is regularly assessed and provides a mechanism to improve the mitigation, based on the factors above, through modification as appropriate.

The proposed rule comment period provides the public an opportunity to submit recommendations, views, and/or concerns regarding the Navy's activities and the proposed mitigation measures. While NMFS has preliminarily determined that the Navy's proposed mitigation measures would effect the least practicable adverse impact on the affected species and their habitat, NMFS will consider all public comments to help inform our final determination. 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, as appropriate, analysis of additional potential mitigation measures.

Proposed Monitoring

Section 101(a)(5)(A) of the MMPA states that in order to authorize incidental take 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 incidental take authorizations 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.

Although the Navy has been conducting research and monitoring for over 20 years in areas where it has been training, it developed a formal marine species monitoring program in support of the GOA Study Area MMPA and ESA processes in 2009. Across all Navy training and testing study areas, the robust marine species monitoring program has resulted in hundreds of technical reports and publications on marine mammals that have informed Navy and NMFS analyses in environmental planning documents, rules, and Biological Opinions. The reports are made available to the public on the Navy's marine species monitoring website (*www.navymarinespeciesmonitoring.us*) and the data on the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS–SEAMAP) (*https://seamap.env.duke.edu/*).

The Navy would continue collecting monitoring data to inform our understanding of the occurrence of marine mammals in the GOA Study Area; the likely exposure of marine mammals to stressors of concern in the GOA Study Area; the response of marine mammals to exposures to stressors; the consequences of a particular marine mammal response to their individual fitness and, ultimately, populations; and the effectiveness of implemented mitigation measures. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the specified activities. The Navy's overall monitoring approach seeks to leverage and build on existing research efforts whenever possible.

As agreed upon between the Navy and NMFS, the monitoring measures presented here, as well as the mitigation measures described above, focus on the protection and management of potentially affected marine mammals. A well-designed monitoring program can provide important feedback for validating assumptions made in analyses and allow for adaptive management of marine resources. Monitoring is required under the MMPA, and details of the monitoring program for the specified activities have been developed through coordination between NMFS and the Navy through the regulatory process for previous Navy at-sea training and testing activities.

Integrated Comprehensive Monitoring Program

The Navy's Integrated Comprehensive Monitoring Program (ICMP) is intended to coordinate marine species 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 flexible, scalable, and adaptable through the adaptive management and strategic planning processes to periodically assess progress and reevaluate objectives. This process includes conducting an annual adaptive management review meeting, at which the Navy and NMFS jointly consider the prior-year goals, monitoring results, and related scientific advances to determine if monitoring plan modifications are warranted to more effectively address program goals. Although the ICMP does not specify actual monitoring field work or individual projects, it does establish a matrix of goals and objectives that have been developed in coordination with NMFS. As the ICMP is implemented through the Strategic Planning Process, detailed and specific studies will be developed which support the Navy's and NMFS 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 or accomplish one or more of the following top-level goals:

- An increase in the understanding of the likely occurrence of marine mammals and ESA-listed marine species in the vicinity of the action (*i.e.,* presence, abundance, distribution, and density of species);
- An increase in the understanding of the nature, scope, or context of the likely exposure of marine mammals and ESA-listed species to any of the potential stressors associated with the action (*e.g.,* sound, explosive detonation, or expended materials), through better understanding of one or more of the following: (1) the nature of the action and its surrounding environment (*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 ESA-listed marine species with the action (in whole or part), and (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and ESA-listed marine species (*e.g.,* age class of exposed animals or known pupping, calving, or feeding areas);
- An increase in the 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 the 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 impacts on annual rates of recruitment or survival);
- An increase in the understanding of the effectiveness of mitigation and monitoring measures;
- A better understanding and record of the manner in which the Navy complies with the incidental take regulations and LOAs and the ESA Incidental Take Statement;
- An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals; and
- Ensuring that adverse impacts of activities remain at the least practicable level.

Strategic Planning Process for Marine Species Monitoring

The Navy also developed the Strategic Planning Process for Marine Species Monitoring, which serves to guide the investment of resources to most efficiently address ICMP objectives and intermediate scientific objectives developed through this process. The

Strategic Planning Process 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 intermediate scientific objectives and a conceptual framework incorporating a progression of knowledge spanning occurrence, exposure, response, and consequence. The Strategic Planning Process for Marine Species Monitoring is used to set overarching intermediate scientific objectives; develop individual monitoring project concepts; evaluate, prioritize, and select specific monitoring projects to fund or continue supporting for a given fiscal year; execute and manage selected monitoring projects; and report and evaluate progress and results. This process addresses 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. More information on the Strategic Planning Process for Marine Species Monitoring including results, reports, and publications, is also available online (*https://www.navymarinespecies monitoring.us/).*

Past and Current Monitoring in the GOA Study Area

The monitoring program has undergone significant changes since the first rule was issued for the TMAA in 2011, which highlights the monitoring program's evolution through the process of adaptive management. The monitoring program developed for the first cycle of environmental compliance documents (*e.g.,* U.S. Department of the Navy, 2008a, 2008b) utilized effort-based compliance metrics that were somewhat limiting. Through adaptive management discussions, the Navy designed and conducted monitoring studies according to scientific objectives and eliminated specific effort requirements.

Progress has also been made on the conceptual framework categories from the Scientific Advisory Group for Navy Marine Species Monitoring (U.S. Department of the Navy, 2011), ranging from occurrence of animals, to their exposure, response, and population consequences. The Navy continues to manage the Atlantic and Pacific program as a whole, including what is now the GOA Study Area, with monitoring in each range complex taking a slightly different but complementary approach. The Navy has continued to use the approach of layering multiple simultaneous components in many of the range complexes to leverage an increase in return of the progress toward answering scientific monitoring questions. This includes in the TMAA, for example (a) Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area May to September 2015 and April to September 2017 (Rice *et al.,* 2018b); (b) analysis of existing passive acoustic monitoring datasets; and (c) Passive Acoustic Monitoring of Marine Mammals Using Gliders (Klinck *et al.,* 2016).

Numerous publications, dissertations, and conference presentations have resulted from research conducted under the marine species monitoring program, including research conducted in what is now the GOA Study Area (*https://www.navymarinespeciesmonitoring.us/reading-room/publications/*), leading to a significant contribution to the body of marine mammal science. Publications on occurrence, distribution, and density have fed the modeling input, and publications on exposure and response have informed Navy and NMFS analysis of behavioral response and consideration of mitigation measures.

Furthermore, collaboration between the monitoring program and the Navy's research and development (*e.g.,* the Office of Naval Research) and demonstration-validation (*e.g.,* Living Marine Resources) programs has been strengthened, leading to research tools and products that have already transitioned to the monitoring program. These include Marine Mammal Monitoring on Ranges, controlled exposure experiment behavioral response studies, acoustic sea glider surveys, and global positioning system-enabled satellite tags. Recent progress has been made with better integration with monitoring across all Navy at-sea study areas, including the AFTT Study Area in the Atlantic Ocean, and various other ranges. Publications from the Living Marine Resources and Office of Naval Research programs have also resulted in significant contributions to hearing, acoustic criteria used in effects modeling, exposure, and response, as well as in developing tools to assess biological significance (*e.g.,* consequences).

NMFS and the Navy also consider data collected during procedural mitigations as monitoring. Data are collected by shipboard personnel on hours spent training, hours of observation, hours of sonar, and marine mammals observed within the mitigation zones when mitigations are implemented. These data are provided to NMFS in both classified and unclassified annual training reports, which would continue under this proposed rule.

NMFS has received multiple years' worth of annual training and monitoring reports addressing active sonar use and explosive detonations within the 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 GOA Study Area. The Navy's annual training and monitoring reports may be viewed at: *https://www.navymarinespecies monitoring.us/reporting/.*

The Navy's marine species monitoring program supports monitoring projects in the GOA Study Area. Additional details on the scientific objectives for each project can be found at *https://www.navymarinespeciesmonitoring.us/regions/pacific/current-projects/.* Projects can be either major multi-year efforts, or one to 2-year special studies. The emphasis on monitoring in the GOA Study Area is directed towards collecting and analyzing passive acoustic monitoring and telemetry data for marine mammals and salmonids.

Specific monitoring under the previous regulations (which covered only the TMAA) included:

- The continuation of the Navy's collaboration with NOAA on the *Pacific Marine Assessment Program for Protected Species (PacMAPPS)* survey. A systematic line transect survey in the Gulf of Alaska was completed in 2021. A second PacMAPPS survey is planned for the Gulf of Alaska in 2023. These surveys will increase knowledge of marine mammal occurrence, density, and population identity in the TMAA.
- A *Characterizing the Distribution of ESA-Listed Salmonids in Washington and Alaska* study. The goal of this study is to use a combination of acoustic and pop-up satellite tagging technology to provide critical information on spatial and temporal distribution of salmonids to inform salmon management, U.S. Navy training activities, and Southern Resident killer whale conservation. The study seeks to (1) determine the occurrence and timing of salmonids within the Navy training ranges; (2) describe the influence of environmental covariates on salmonid occurrence; and (3) describe the occurrence of salmonids in relation to Southern Resident killer whale distribution. Methods include acoustic telemetry (pinger tags) and pop-up satellite tagging.
- A *Telemetry and Genetic Identity of Chinook Salmon in Alaska* study. The goal of this study is to provide critical

information on the spatial and temporal distribution of Chinook salmon and to utilize genetic analysis techniques to inform salmon management. Tagging is occurring at several sites within the Gulf of Alaska.

• A *North Pacific Humpback Whale Tagging* study. This project combines tagging, biopsy sampling, and photo-identification efforts along the United States west coast and Hawaii to examine movement patterns and whale use of Navy training and testing areas and NMFS-identified BIAs, examine migration routes, and analyze dive behavior and ecological relationships between whale locations and oceanographic conditions (Mate *et al.,* 2017; Irvine *et al.,* 2020).

Future monitoring efforts in the GOA Study Area are anticipated to continue along the same objectives: determining the species and populations of marine mammals present and potentially exposed to Navy training activities in the GOA Study Area, through tagging, passive acoustic monitoring, refined modeling, photo identification, biopsies, and visual monitoring, as well as characterizing spatial and temporal distribution of salmonids, including Chinook salmon.

Adaptive Management

The proposed regulations governing the take of marine mammals incidental to Navy training activities in the GOA Study Area contain an adaptive management component. Our understanding of the effects of Navy training activities (*e.g.,* acoustic and explosive stressors) on marine mammals continues to evolve, which makes the inclusion of an adaptive management component both valuable and necessary within the context of 7-year regulations.

The reporting requirements associated with this rule are designed to provide NMFS with monitoring data from the previous year to allow NMFS to consider whether any changes to existing mitigation and monitoring requirements 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 more effectively accomplishing the goals of the mitigation and monitoring and if the measures are practicable. If the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS would publish a notice of the planned LOA in the **Federal Register** and solicit public comment.

The following are some of the possible sources of applicable data to be considered through the adaptive management process: (1) results from monitoring and exercise reports, as required by MMPA authorizations; (2) compiled results of Navy funded research and development 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. The results from monitoring reports and other studies may be viewed at *https://www.navymarinespeciesmonitoring.us.*

Proposed Reporting

In order to issue incidental take authorization 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. 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: *https://www.navymarinespeciesmonitoring.us.*

There are several different reporting requirements pursuant to the 2017–2022 regulations. All of these reporting requirements would be continued under this proposed rule for the 7-year period; however, the reporting schedule for the GOA Annual Training Report would be slightly changed to align the reporting schedule with the activity period (see the *GOA Annual Training Report* section, below*).*

Notification of Injured, Live Stranded, or Dead Marine Mammals

The Navy would consult the Notification and Reporting Plan, which sets out notification, reporting, and other requirements when injured, live stranded, or dead marine mammals are detected. The Notification and Reporting Plan is available for review at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities.*

Annual GOA Marine Species Monitoring Report

The Navy would submit an annual report to NMFS of the GOA Study Area monitoring, which would be included in a Pacific-wide monitoring report and include results specific to the GOA Study Area, describing the implementation and results of monitoring from the previous calendar year. Data collection methods would be standardized across Pacific Range Complexes including the MITT, HSTT, NWTT, and GOA Study Areas to the best extent practicable, to allow for comparison among different geographic locations. The report would be submitted to the Director, Office of Protected Resources, NMFS, either within 3 months after the end of the calendar year, or within 3 months after the conclusion of the monitoring year, to be determined by the Adaptive Management process. NMFS would submit comments or questions on the draft monitoring report, if any, within 3 months of receipt. The report would be considered final after the Navy has addressed NMFS' comments, or 3 months after submittal if NMFS does not provide comments on the report. The report would describe progress of knowledge made with respect to monitoring study questions across multiple Navy ranges associated with the ICMP. Similar study questions would be treated together so that progress on each topic is 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. This would allow the Navy to provide a cohesive monitoring report covering multiple ranges (as per ICMP goals), rather than entirely separate reports for the MITT, HSTT, NWTT, and GOA Study Areas.

GOA Annual Training Report

Each year in which training activities are conducted in the GOA Study Area, the Navy would submit one preliminary report (Quick Look Report) to NMFS detailing the status of applicable sound sources within 21 days after the completion of the training activities in the GOA Study Area. Each year in which activities are conducted, the Navy would also submit a detailed report (GOA Annual Training Report) to NMFS within 3 months after completion of the training activities. The Phase II rule required the Navy to submit the GOA Annual Training Report within 3 months after the anniversary of the date of issuance of the LOA. NMFS would submit comments or questions on the report, if any, within one month of receipt. The report would be considered final after the Navy has addressed NMFS' comments, or one month after submittal if NMFS does not provide comments on the report. The annual reports would contain information about the MTE, (exercise designator, date that the exercise began and ended, location, number and types of active and passive sonar sources used in the exercise, number and types of vessels and aircraft that participated in the exercise, *etc.*), individual marine mammal sighting information for each sighting in each exercise where mitigation was implemented, a mitigation effectiveness evaluation, and a summary of all sound sources used (total hours or quantity of each bin of sonar or other non-impulsive source; total annual number of each type of explosive(s); and total annual expended/detonated rounds (bombs and large-caliber projectiles) for each explosive bin).

The annual report (which, as stated above, would only be required during years in which activities are conducted) would also contain cumulative sonar and explosive use quantity from previous years' reports through the current year. Additionally, if there were any changes to the sound source allowance in the reporting year, or cumulatively, the report would include a discussion of why the change was made and include analysis to support how the change did or did not affect the analysis in the GOA SEIS/OEIS and MMPA final rule. The analysis in the detailed report would be based on the accumulation of data from the current year's report and data collected from previous annual reports. The final annual/close-out report at the conclusion of the authorization period (year seven) would also serve as the comprehensive close-out report and include both the final year annual use compared to annual authorization as well as a cumulative 7-year annual use compared to 7-year authorization. This report would also note any years in which training did not occur. NMFS must submit comments on the draft close-out report, if any, within 3 months of receipt. The report would 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. Information included in the annual reports may be used to inform future adaptive management of activities within the GOA Study Area. See the regulations below for more detail on the content of the annual report.

Other Reporting and Coordination

The Navy would continue to report and coordinate with NMFS for the following:

- Annual marine species monitoring technical review meetings that also include researchers and the Marine Mammal Commission; and
- Annual Adaptive Management meetings that also include the Marine Mammal Commission (and occur in conjunction with the annual marine species monitoring technical review meetings).

Preliminary Analysis and Negligible Impact Determination

General Negligible Impact Analysis

Introduction

NMFS has defined negligible impact 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 (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. For Level A harassment or Level B harassment (as presented in Table 30), in addition to considering estimates of the number of marine mammals that might be taken NMFS considers other factors, such as the likely nature of any responses (*e.g.,* intensity, duration) and the context of any responses (*e.g.,* critical reproductive time or location, migration), as well as effects on habitat and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS' implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, other ongoing sources of human-caused mortality, and ambient noise levels).

In the Estimated Take of Marine Mammals section, we identified the subset of potential effects that would be expected to rise to the level of takes both annually and over the 7-year period covered by this proposed rule, and then identified the maximum number of harassment takes that are reasonably expected to occur based on the methods described. The impact that any given take would have is dependent on many case-specific factors that need to be considered in the negligible impact analysis (*e.g.,* the context of behavioral exposures such as duration or intensity of a disturbance, the health of impacted animals, the status of a species that incurs fitness-level impacts to individuals, *etc.*). For this proposed rule we evaluated the likely impacts of the enumerated maximum number of harassment takes that are proposed for authorization and reasonably expected to occur, in the context of the specific circumstances surrounding these predicted takes. Last, we collectively evaluated this information, as well as other more taxa-specific information and mitigation measure effectiveness, in group-specific assessments that support our negligible impact conclusions for each stock or species. Because all of the Navy's specified activities would occur within the ranges of the marine mammal stocks identified in the rule, all negligible impact analyses and determinations are at the stock level (*i.e.,* additional species-level determinations are not needed).

As explained in the Estimated Take of Marine Mammals section, no take by serious injury or mortality is authorized or anticipated to occur. There have been no recorded Navy vessel strikes of any marine mammals during training in the GOA Study Area to date, nor were incidental takes by injury or mortality resulting from vessel strike predicted in the Navy's analysis. For these and the other reasons described in the *Potential Effects of Vessel Strike* section, NMFS concurs that vessel strike is not likely to occur during the 21-day GOA Study Area training activities, and therefore is not proposing authorization in this rule.

The specified activities reflect representative levels of training activities. The Description of the Specified Activity section describes annual activities. There may be some flexibility in the exact number of hours, items, or detonations that may vary from year to year, but take totals would not exceed the maximum annual totals and 7-year totals indicated in Table 30. (Further, as noted previously, the GOA Study Area training activities would not occur continuously throughout the year, but rather, for a maximum of 21 days once annually between April and October.) We base our analysis and negligible impact determination on the maximum number of takes that would be reasonably expected to occur annually and are proposed to be authorized, although, as stated before, the number of takes is 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 affected individuals. To avoid repetition, we provide some general analysis immediately below that applies to all the species listed in Table 30, given that some of the anticipated effects 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 (and/or stocks), or groups of species (and the associated stocks) where relevant similarities exist, to provide more specific information related to the anticipated effects on individuals of a specific stock or where there is information about the status or structure of any species or stock that would lead to a differing assessment of the effects on the species or stock. Organizing our analysis by grouping species or stocks that share common traits or that would respond similarly to effects of the Navy's activities and then providing species- or stock-specific information allows us to avoid duplication while assuring that we have analyzed the effects of the specified activities on each affected species or stock.

Harassment

The Navy's harassment take request is based on a model and quantitative assessment of mitigation, which NMFS reviewed and concurs appropriately predicts the maximum amount of harassment that is reasonably likely to occur, with the exception of the Eastern North Pacific stock of gray whale, and the Western North Pacific stock of humpback whale, for which NMFS has proposed authorizing 4 and 3 Level B harassment takes annually, respectively, as described in the Estimated Take of Marine Mammals section. 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 energy received by a marine mammal exceeds the thresholds for effects. Assumptions in the Navy model intentionally err on the side of overestimation when there are unknowns. Naval activities are modeled as though they would occur regardless of proximity to marine mammals, meaning that no mitigation is considered (*e.g.,* no power down or shut down) and without any avoidance of the activity by the animal. As described above in the Estimated Take of Marine Mammals section, no mortality was modeled for any species for the TMAA activities, and therefore the quantitative post-modeling analysis that allows for the consideration of mitigation to prevent mortality, which has been applied in other Navy rules, was appropriately not applied here. (Though, as noted in the Estimated Take of Marine Mammals section, where the analysis indicates mitigation would effectively reduce risk, the model-estimated PTS are considered reduced to TTS.) NMFS provided input to, independently reviewed, and concurs with the Navy on this process and the Navy's analysis, which is described in detail in Section 6 of the Navy's rulemaking/LOA application, that was used to quantify harassment takes for this rule.

Generally speaking, 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 for behavioral effects throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels. However, there is also growing evidence of the importance of distance in predicting marine mammal behavioral response to sound—*i.e.,* sounds of a similar level emanating from a more distant source have been shown to be less likely to evoke a response of equal magnitude (DeRuiter 2012, Falcone *et al.* 2017). The estimated number of takes by Level A harassment and Level B harassment 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 A harassment and Level B harassment threshold) that are anticipated to occur annually and over the 7-year period. These instances may represent either brief exposures (seconds or minutes) or, in some cases, longer durations of exposure within a day. Some individuals may experience multiple instances of take (meaning over multiple days) over the course of the 21 day exercise, which means that the number of individuals taken is smaller than the total estimated takes. Generally speaking, the higher the number of takes as compared to the population abundance, the more repeated takes of individuals are likely, and the higher the actual percentage of individuals in the population that are likely taken at least once in a year. We look at this comparative metric to give us a relative sense of where a larger portion of a species is being taken by Navy activities, where there is a higher likelihood that the same individuals are being taken across multiple days, and where that number of days might be higher or more likely sequential. Where the number of instances of take is less than 100 percent of the abundance and there is no information to specifically suggest that a small subset of animals is being repeatedly taken over a high number of sequential days, the overall magnitude is generally considered low, as it could on one extreme mean that every take represents a separate individual in the population being taken on one day (a very minimal impact) or, more likely, that some smaller number of individuals are taken on one day annually and some are taken on a few not likely sequential days annually, while some are not taken at all.

In the ocean, the use of sonar and other active acoustic sources is often transient and is unlikely to repeatedly expose the same individual animals within a short period, for example within one specific exercise. However, for some individuals of some species repeated exposures across different activities could occur across the 21-day period. In short, for some species we expect that the total anticipated takes represent exposures of a smaller number of individuals of which some would be exposed multiple times, but based on the nature of the Navy activities and the movement patterns of marine mammals, it is unlikely that individuals from most stocks would be taken over more than a few non-sequential days. This means that even where repeated takes of individuals may occur, they are more likely to result from non-sequential exposures from different activities, and, even if a few individuals were taken on sequential days, they are not predicted to be taken for more than a few days in a row, at most. As described elsewhere, the nature of the majority of the exposures would be expected to be of a less severe nature and based on the numbers and duration of the activity (no more than 21 days) any individual exposed multiple times is still only taken on a small percentage of the days of the year.

Physiological Stress Response

Some of the lower level physiological stress responses (*e.g.,* orientation or startle response, change in respiration, change in heart rate) discussed earlier would 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. Takes by Level A harassment or Level B harassment, then, may have a stress-related physiological component as well; however, we would not expect the Navy's generally short-term, intermittent, and (typically 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 that could affect reproduction or survival.

Behavioral Response

The estimates calculated using the BRF do not differentiate between the different types of behavioral responses that rise to the level of take by Level B harassment. As described in the Navy's application, the Navy identified (with NMFS' input) the types of behaviors that would be considered a take: Moderate behavioral responses as characterized in Southall *et al.* (2007) (*e.g.,* altered migration paths or dive profiles, interrupted nursing, breeding or feeding, or avoidance) that also would be expected to continue for the duration of an exposure. The Navy then compiled the available data indicating at what received levels and distances those responses have occurred, and used the indicated literature to build biphasic behavioral response curves that are used to predict how many instances of Level B harassment by behavioral disturbance occur in a day. Take estimates alone do not provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. We therefore consider the available activity-specific, environmental, and species-specific information to determine the likely nature of the modeled behavioral responses and the potential fitness consequences for affected individuals.

Use of sonar and other transducers would typically be transient and temporary. The majority of acoustic effects to individual animals from sonar and other active sound sources during training activities would be primarily from ASW events. It is important to note that although ASW is one of the warfare areas of focus during Navy training, there are significant periods when active ASW sonars are not in use. Behavioral reactions are assumed more likely to be significant during MTEs than during other ASW activities due to the use of high-powered ASW sources as well as the duration (*i.e.,* multiple days) and scale (*i.e.,* multiple sonar platforms) of the MTEs.

On the less severe end, exposure to comparatively lower levels of sound at a detectably greater distance from the animal, for a few or several minutes, could result in a behavioral response such as avoiding an area that an animal would otherwise have moved through or fed in, or breaking off one or a few feeding bouts. More severe effects could occur when the animal gets close enough to the source to receive a comparatively higher level of sound, is exposed continuously to one source for a longer time, or is exposed intermittently to different sources throughout a day. Such effects might result in an animal having a more severe flight response and leaving a larger area for a day or more or potentially losing feeding opportunities for a day. However, such severe behavioral effects are expected to occur infrequently.

To help assess this, for sonar (MFAS/HFAS) used in the TMAA, the Navy provided information estimating the percentage of animals that may be taken by Level B harassment under each BRF that would occur within 6-dB increments (percentages discussed below in the *Group and Species-Specific Analyses* section). As mentioned above, all else being equal, an animal's exposure to a higher received level is more likely to result in a behavioral response that is more likely to lead to adverse effects, which could more likely accumulate to impacts on reproductive success or survivorship of the animal, but other contextual factors (such as distance) are also important. The majority of takes by Level B harassment 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 shorter duration. We anticipate more severe effects from takes when animals are exposed to higher received levels of sound or at closer proximity to the source. Because species belonging to taxa that share common characteristics are likely to respond and be affected in similar ways, these discussions are presented within each species group below in the *Group and Species-Specific Analyses* section. As noted previously in this proposed rule, behavioral responses vary considerably between species, between individuals within a species, and across contexts of different exposures. Specifically, given a range of behavioral responses that may be classified as Level B harassment, to the degree that higher received levels of sound are expected to result in more severe behavioral responses, only a smaller percentage of the anticipated Level B harassment from Navy activities might necessarily be expected to potentially result in more severe responses (see the *Group and Species-Specific Analyses* section below for more detailed information). To fully understand the likely impacts of the predicted/proposed authorized take on an individual (*i.e.,* what is the likelihood or degree of fitness impacts), one must look closely at the available contextual information, such as the duration of likely exposures and the likely severity of the exposures (*e.g.,* whether they would occur for a longer duration over sequential days or the comparative sound level that would be received). Ellison *et al.* (2012) and Moore and Barlow (2013), among others, emphasize 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.

Diel Cycle

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). Henderson *et al.* (2016) found that ongoing smaller scale events had little to no impact on foraging dives for Blainville's beaked whale, while multi-day training events may decrease foraging behavior for Blainville's beaked whale (Manzano-Roth *et al.,* 2016). 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 ASW activities, typically include vessels that are continuously moving at speeds typically 10–15 kn (19–28 km/hr), or higher, and likely cover large areas that are relatively far from shore (typically more than 3 nmi (6 km) from shore) and in waters greater than 600 ft (183 m) deep. Additionally 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. Further, 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. However, it is also worth noting that the Navy conducts many different types of noise-producing activities over the course of the 21-day exercise, and it is likely that some marine mammals will be exposed to more than one activity and taken on multiple days, even if they are not sequential.

Durations of Navy activities utilizing tactical sonar sources and explosives vary and are fully described in Appendix A (*Navy Activity Descriptions*) of the 2020 GOA DSEIS/OEIS. Sonar used during ASW would impart the greatest amount of acoustic energy of any category of sonar and other transducers analyzed in the Navy's rulemaking/LOA application and include hull-mounted, towed array, sonobuoy, and helicopter dipping sonars. Most ASW sonars are MFAS (1–10 kHz); however, some sources may use higher frequencies. ASW training activities using hull mounted sonar proposed for the TMAA generally last for only a few hours (see Appendix A (*Navy Activity Descriptions*) of the 2020 GOA DSEIS/OEIS). Some ASW training activities typically last about 8 hours. Because of the need to train in a large variety of situations, the Navy does not typically conduct successive ASW exercises in the same locations. Given the average length of ASW exercises (times of sonar use) and typical vessel speed, combined with the fact that the majority of the cetaceans would not likely remain in proximity to the sound source, it is unlikely that an animal would be exposed to MFAS/HFAS at levels or durations likely to result in a substantive response that would then be carried on for more than 1 day or on successive days (and as noted previously, no LFAS use is planned by the Navy).

Most planned explosive events are scheduled to occur over a short duration (1–3 hours); however, the explosive component of these activities only lasts for minutes. 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, or demonstrate sustained behavioral responses. All of these factors make it unlikely that individuals would be exposed to the exercise for extended periods or on consecutive days, though some individuals may be exposed on multiple days.

Assessing the Number of Individuals Taken and the Likelihood of Repeated Takes

As described previously, Navy modeling uses the best available science to predict the instances of exposure above certain acoustic thresholds, which are equated, as appropriate, to harassment takes (and further corrected to account for mitigation and avoidance). As further noted, for active acoustics it is more challenging to parse out the number of individuals taken by Level B harassment and the number of times those individuals are taken from this larger number of instances. One method that NMFS uses to help better understand the overall scope of the impacts is to compare these total instances of take against the abundance of that species (or stock if applicable). For example, if there are 100 harassment takes in a population of 100, one can assume either that every individual was exposed above acoustic thresholds in no more than one day, or that some smaller number were exposed in one day but a few of those individuals were exposed multiple days within a year and a few were not exposed at all. Where the instances of take exceed 100 percent of the population, multiple takes of some individuals are predicted and expected to occur within a year. Generally speaking, the higher the number of takes as compared to the population abundance, the more multiple takes of individuals are likely, and the higher the actual percentage of individuals in the population that are likely taken at least once in a year. We look at this comparative metric to give us a relative sense of where larger portions of the species or stock are being taken by Navy activities and where there is a higher likelihood that the same individuals are being taken across multiple days and where that number of days might be higher. It also provides a relative picture of the scale of impacts to each species or stock.

In the ocean, unlike a modeling simulation with static animals, the use of sonar and other active acoustic sources is often transient, and is unlikely to repeatedly expose the same individual animals within a short period, for example within one specific exercise. However, some repeated exposures across different activities could occur over the year with more resident species. Nonetheless, the episodic nature of activities in the TMAA (21 days per year) would mean less frequent exposures as compared to some other ranges. In short, we expect that for some stocks, the total anticipated takes represent exposures of a smaller number of individuals of which some could be exposed multiple times, but based on the nature of the Navy's activities and the movement patterns of marine mammals, it is unlikely that individuals of most species or stocks would be taken over more than a few non-sequential days within a year.

When calculating the proportion of a population affected by takes (*e.g.,* the number of takes divided by population abundance), which can also be helpful in estimating the number of days over which some individuals may be taken, it is important to choose an appropriate population estimate against which to make the comparison. The SARs, where available, provide the official population estimate for a given species or stock in U.S. waters in a given year (and are typically based solely on the most recent survey data). When the stock is known to range well outside of U.S. Exclusive Economic Zone (EEZ) boundaries, population estimates based on surveys conducted only within the U.S. EEZ are known to be underestimates. The information used to estimate take includes the best available survey abundance data to model density layers. Accordingly, in calculating the percentage of takes versus abundance for each species or stock in order to assist in understanding both the percentage of the species or stock affected, as well as how many days across a year individuals could be taken, we use the data most appropriate for the situation. For the GOA Study Area, for all species and stocks except for beaked whales for which SAR data are unavailable, the most recent NMFS SARs are used to calculate the proportion of a population affected by takes.

The estimates found in NMFS' SARs remain the official estimates of stock abundance where they are current. These estimates are typically generated from the most recent shipboard and/or aerial surveys conducted. In some cases, NMFS' abundance estimates show substantial year-to-year variability. However, for highly migratory species (*e.g.,* large whales) or those whose geographic distribution extends well beyond the boundaries of the GOA Study Area (*e.g.,* populations with distribution along the entire eastern Pacific Ocean rather than just the GOA Study Area), comparisons to the SAR are appropriate. Many of the stocks present in the GOA Study Area have ranges significantly larger than the GOA Study Area and that abundance is captured by the SAR. A good descriptive example is migrating large whales, which occur seasonally in the GOA. Therefore, at any one time there may be a stable number of animals, but over the course of the potential activity period (April to October), the entire population could occur in the GOA Study Area. Therefore, comparing the estimated takes to an abundance, in this case the SAR abundance, which represents the total population, may be more appropriate than modeled abundances for only the GOA Study Area.

Temporary Threshold Shift

NMFS and the Navy have estimated that most species or stocks of marine mammals in the TMAA may sustain some level of TTS from active sonar. As mentioned previously, in general, TTS can last from a few minutes to days, be of varying degree, and occur across various frequency bandwidths, all of which determine the severity of the impacts on the affected individual, which can range from minor to more severe. Table 41 to Table 46 indicate the number of takes by TTS that may be incurred by different species and stocks from exposure to active sonar and explosives. 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 Navy's MF sources, which are the highest power and most numerous sources and the ones that cause the most take, utilize the 1–10 kHz frequency band, which suggests that if TTS were to be induced by any of these MF sources it would be in a frequency band somewhere between approximately 2 and 20 kHz, which is in the range of communication calls for many odontocetes, but below the range of the echolocation signals used for foraging. 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 10 and 100 kHz, which means that TTS could range up to 200 kHz), which could overlap with the range in which some odontocetes communicate or echolocate. 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 unlikely. As noted previously, the Navy proposes no LFAS use for the activities in this rulemaking. The frequency provides information about the cues to which a marine mammal may be temporarily less sensitive, but not the degree or duration of sensitivity loss. The majority of sonar sources from which TTS may be incurred occupy a narrow frequency band, which means that the TTS incurred would also be across a narrower band (*i.e.,* not affecting the majority of an animal's hearing range). TTS from explosives would be broadband.

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 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 kn; 19–28 km/hr) and the relative motion between the sonar vessel and the animal. In the TTS studies discussed in the Potential Effects of Specified Activities on Marine Mammals and their Habitat 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, since any hull-mounted sonar such as the SQS–53 (MFAS), emits a ping typically every 50 seconds, incurring those levels of TTS is highly unlikely. Since any hull-mounted sonar, such as the SQS–53, engaged in anti-submarine warfare training would be moving at between 10 and 15 kn (19–28 km/hr) and nominally pinging every 50 seconds, the vessel would have traveled a minimum distance of approximately 257 m during the time between those pings. A scenario could occur where an animal does not leave the vicinity of a ship or travels a course parallel to the ship, however, the close distances required make TTS exposure unlikely. For a Navy vessel moving at a nominal 10 kn (19 km/hr), it is unlikely a marine mammal could maintain speed parallel to the ship and receive adequate energy over successive pings to suffer TTS.

In short, given the anticipated duration and levels of sound exposure, we would not expect marine mammals to incur more than relatively low levels of TTS (*i.e.,* single digits of sensitivity loss). To add context to this degree of TTS, individual marine mammals may regularly experience variations of 6 dB differences in hearing sensitivity across time (Finneran *et al.,* 2000, 2002; Schlundt *et al.,* 2000).

3. Duration of TTS (recovery time)—In the TTS laboratory studies (as discussed in the Potential Effects of Specified Activities on Marine Mammals and their Habitat 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 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 hours—and any incident of TTS would likely be far less severe due to the short duration of the majority of the events during the 21 days and the speed of a typical vessel, especially given the fact that the higher power sources resulting in TTS are predominantly intermittent, which have been shown to result in shorter durations of TTS. Also, for the same reasons discussed in the Preliminary Analysis and Negligible Impact Determination—*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 would not usually span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues.

Tables 41 to 46 indicate the number of incidental takes by TTS for each species or stock that are likely to result from the Navy's activities. As a general point, the majority of these TTS takes are the result of exposure to hull-mounted MFAS (MF narrower band sources), with fewer from explosives (broad-band lower frequency sources), and even fewer from HFAS sources (narrower band). As described above, we expect the majority of these takes to be in the form of mild (single-digit), short-term (minutes to hours), narrower band (only affecting a portion of the animal's hearing range) TTS. This means that for one to several times within the 21 days, for several minutes to maybe a few hours at most each, a taken individual will have slightly diminished hearing sensitivity (slightly more than natural variation, but nowhere near total deafness). More often than not, such an exposure would occur within a narrower mid- to higher frequency band that may overlap part (but not all) of a communication, echolocation, or predator range, but sometimes across a lower or broader bandwidth. The significance of TTS is also related to the auditory cues that are germane within the time period that the animal incurs the TTS. For example, if an odontocete has TTS at echolocation frequencies, but incurs it at night when it is resting and not feeding, it is not impactful. In short, the expected results of any one of these limited number of mild TTS occurrences could be that (1) it does not overlap signals that are pertinent to that animal in the given time period, (2) it overlaps parts of signals that are important to the animal, but not in a manner that impairs interpretation, or (3) it reduces detectability of an important signal to a small degree for a short amount of time—in which case the animal may be aware and be able to compensate (but there may be slight energetic cost), or the animal may have some reduced opportunities (*e.g.,* to detect prey) or reduced capabilities to react with maximum effectiveness (*e.g.,* to detect a predator or navigate optimally). However, given the small number of times that any individual might incur TTS, the low degree of TTS and the short anticipated duration, and the low likelihood that one of these instances would occur in a time period in which the specific TTS overlapped the entirety of a critical signal, it is unlikely that TTS of the nature expected to result from the Navy activities would result in behavioral changes or other impacts that would impact any individual's (of any hearing sensitivity) reproduction or survival.

Auditory Masking or Communication Impairment

The ultimate potential impacts of masking on an individual (if it were to occur) are similar to those discussed for TTS, but an important difference is that masking only occurs during the time of the signal, versus TTS, which continues beyond the duration of the signal. Fundamentally, masking is referred to as a chronic effect because one of the key harmful components of masking is its duration—the fact that an animal would have reduced ability to hear or interpret critical cues becomes much more likely to cause a problem the longer it is occurring. Also inherent in the concept of masking is the fact that the potential for the effect is only present during the times that the animal and the source are in close enough proximity for the effect to occur (and further, this time period would need to coincide with a time that the animal was utilizing sounds at the masked frequency). As our analysis has indicated, because of the relative movement of vessels and the species involved in this rule, we do not expect the exposures with the potential for masking to be of a long duration. In addition, masking is fundamentally more of a concern at lower frequencies, because low frequency signals propagate significantly further than higher frequencies and because they are more likely to overlap both the narrower LF calls of mysticetes, as well as many non-communication cues such as fish and invertebrate prey, and geologic sounds that inform navigation (although the Navy proposes no LFAS use for the activities in this rulemaking). Masking is also more of a concern from continuous sources (versus intermittent sonar signals) where there is no quiet time between pulses within which auditory signals can be detected and interpreted. For these reasons, dense aggregations of, and long exposure to, continuous LF activity are much more of a concern for masking, whereas comparatively short-term exposure to the predominantly intermittent pulses of often narrow frequency range MFAS or HFAS, or explosions are not expected to result in a meaningful amount of masking. While the Navy occasionally uses LF and more continuous sources (although, as noted above, the Navy proposes no LFAS use for the activities in this rulemaking), it is not in the contemporaneous aggregate amounts that would accrue to a masking concern. Specifically, the nature of the activities and sound sources used by the Navy do not support the likelihood of a level of masking accruing that would have the potential to affect reproductive success or survival. Additional detail is provided below.

Standard hull-mounted MFAS typically pings every 50 seconds. Some hull-mounted anti-submarine sonars can also be used in an object detection mode known as ''Kingfisher'' mode (*e.g.,* used on vessels when transiting to and from port) where pulse length is shorter but pings are much closer together in both time and space since the vessel goes slower when operating in this mode (note also that the duty cycle for MF11 and MF12 sources is greater than 80 percent). For the majority of other sources, the pulse length is significantly shorter than hull-mounted active sonar, on the order of several microseconds to tens of milliseconds. Some of the vocalizations that many marine mammals make are less than one second long, so, for example with hull-mounted sonar, there would be a 1 in 50 chance (only if the source was in close enough proximity for the sound to exceed the signal that is being detected) that a single vocalization might be masked by a ping. However, when vocalizations (or series of vocalizations) are longer than one second, masking would not occur. Additionally, when the pulses are only several microseconds long, the majority of most animals' vocalizations would not be masked.

Most ASW sonars and countermeasures use MF frequencies and a few use HF frequencies. Most of these sonar signals are limited in the temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. A few systems operate with higher duty cycles or nearly continuously, but they typically use lower power, which means that an animal would have to be closer, or in the vicinity for a longer time, to be masked to the same degree as by a higher level source. Nevertheless, masking could occasionally occur at closer ranges to these high-duty cycle and continuous active sonar systems, but as described previously, it would be expected to be of a short duration when the source and animal are in close proximity. While data are limited on behavioral responses of marine mammals to continuously active sonars (Isojunno *et al.,* 2020), mysticete species are known to be able to habituate to novel and continuous sounds (Nowacek *et al.,* 2004), suggesting that they are likely to have similar responses to high-duty cycle sonars. Furthermore, most of these systems are hull-mounted on surface ships with the ships moving at least 10 kn (19 km/hr), and it is unlikely that the ship and the marine mammal would continue to move in the same direction and the marine mammal subjected to the same exposure due to that movement. Most ASW activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most ASW sonars also have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant masking. HF signals (above 10 kHz) attenuate more rapidly in the water due to absorption than do lower frequency signals, thus producing only a very small zone of potential masking. If masking or communication impairment were to occur briefly, it would more likely be in the frequency range of MFAS (the more powerful source), which overlaps with some odontocete vocalizations (but few mysticete 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 resemble the characteristics of any single marine mammal species' vocalizations.

Other sources used in Navy training that are not explicitly addressed above, 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. For the reasons described here, any limited masking that could potentially occur would be minor and short-term.

In conclusion, masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as from vessels, however, the duration of temporal and spatial overlap with any individual animal and the spatially separated sources that the Navy uses would not be expected to result in more than short-term, low impact masking that would not affect reproduction or survival.

PTS From Sonar Acoustic Sources and Explosives and Non-Auditory Tissue Damage From Explosives

Tables 41 to 46 indicate the number of individuals of each species or stock for which Level A harassment in the form of PTS resulting from exposure to active sonar and/or explosives is estimated to occur. The Northeast Pacific stock of fin whale, Alaska stock of Dall's porpoise, and California stock of Northern elephant seal are the only stocks which may incur PTS (from sonar and explosives). For all other species/stocks only take by Level B harassment (behavioral disturbance and/or TTS) is anticipated. No species/stocks have the potential to incur non-auditory tissue damage from training activities.

Data suggest 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-emitting vessel at a close distance, NMFS has determined that the mitigation measures (*i.e.,* shutdown/powerdown zones for active sonar) 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 ASW exercises, passive acoustic detections are used as a cue for Lookouts' visual observations when passive acoustic assets are already participating in an activity) in addition to Lookouts on vessels to detect marine mammals for mitigation implementation. As discussed previously, the Navy utilized a post-modeling quantitative assessment to adjust the take estimates based on avoidance and the likely success of some portion of the mitigation measures. As is typical in predicting biological responses, it is challenging to predict exactly how avoidance and mitigation would affect the take of marine mammals. Therefore, in conducting the post-modeling quantitative assessment, the Navy erred on the side of caution in choosing a method that would more likely still overestimate the take by PTS to some degree. Nonetheless, these Level A harassment take numbers represent the maximum number of instances in which marine mammals would be reasonably expected to incur PTS, and we have analyzed them accordingly.

If a marine mammal is able to approach a surface vessel within the distance necessary to incur PTS in spite of the mitigation measures, the likely speed of the vessel (nominally 10–15 kn (19–28 km/hr)) and relative motion of the vessel 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 discussed previously 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. The majority of any PTS incurred as a result of exposure to Navy sources would be expected to be in a narrow band in the 2–20 kHz range (resulting from the most powerful hull-mounted sonar) and could overlap a small portion of the communication frequency range of many odontocetes, whereas other marine mammal groups have communication calls at lower frequencies. Regardless of the frequency band, the more important point in this case is that any PTS accrued as a result of exposure to Navy activities would be expected to be of a small amount (single digits of dB hearing loss). Permanent loss of some degree of hearing is a normal occurrence for older animals, and many animals are able to compensate for the shift, both in old age or at younger ages as the result of stressor exposure. While a small loss of hearing sensitivity may include some degree of energetic costs for compensating or may mean some small loss of opportunities or detection capabilities, at the expected scale it would be unlikely to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival.

The Navy implements mitigation measures (described in the Proposed Mitigation Measures section) during explosive activities, including delaying detonations when a marine mammal is observed in the mitigation zone. Nearly all explosive events would occur during daylight hours to improve the sightability of marine mammals and thereby improve mitigation effectiveness. Observing for marine mammals during the explosive activities would include visual and passive acoustic detection methods (when they are available and part of the activity) before the activity begins, in order to cover the mitigation zones that can range from 200 yd (182.9 m) to 2,500 yd (2,286 m) depending on the source (*e.g.,* explosive bombs; see Table 34 and Table 35). For all of these reasons, the proposed mitigation measures associated with explosives are expected to further ensure that no non-auditory tissue damage occurs to any potentially affected species, and no species are anticipated to incur non-auditory tissue damage during the period of the proposed rule.

Group and Species-Specific Analyses

The maximum amount and type of incidental take of marine mammals reasonably likely to occur and therefore proposed to be authorized from exposures to sonar and other active acoustic sources and in-air explosions at or above the water surface during the 7-year training period are shown in Table 30. The vast majority of predicted exposures (greater than 99 percent) are expected to be non-injurious Level B harassment (TTS and behavioral disturbance) from acoustic and explosive sources during training activities at relatively low received levels. A small number of takes by Level A harassment (PTS only) are predicted for three species (Dall's porpoise, fin whales, and Northern elephant seals).

In the discussions below, the estimated takes by Level B harassment represent instances of take, not the number of individuals taken (the less frequent Level A harassment takes are far more likely to be associated with separate individuals), and in some cases individuals may be taken more than one time. Below, we compare the total take numbers (including PTS, TTS, and behavioral disturbance) for species or stocks to their associated abundance estimates to evaluate the magnitude of impacts across the species and to individuals. Generally, when an abundance percentage comparison is below 100, it means that that percentage or less of the individuals would be affected (*i.e.,* some individuals would not be taken at all), that the average for those taken is one day per year, and that we would not expect any individuals to be taken more than a few times during the 21 days per year. When it is more than 100 percent, it means there would definitely be some number of repeated takes of individuals. For example, if the percentage is 300, the average would be each individual is taken on 3 days in a year if all were taken, but it is more likely that some number of individuals would be taken more than three times and some number of individuals fewer or not at all. While it is not possible to know the maximum number of days across which individuals of a stock might be taken, in acknowledgement of the fact that it is more than the average, for the purposes of this analysis, we assume a number approaching twice the average. For example, if the percentage of take compared to the abundance is 800, we estimate that some individuals might be taken as many as 16 times. Those comparisons are included in the sections below.

To assist in understanding what this analysis means, we clarify a few issues related to estimated takes and the analysis here. An individual that incurs a PTS or TTS take may sometimes, for example, also be subject to behavioral disturbance at the same time. As described above in this section, the degree of PTS, and the degree and duration of TTS, expected to be incurred from the Navy's activities are not expected to impact marine mammals such that their reproduction or survival could be affected. Similarly, data do not suggest that a single instance in which an animal accrues PTS or TTS and is also subjected to behavioral disturbance would result in impacts to reproduction or survival. Alternately, we recognize that if an individual is subjected to behavioral disturbance repeatedly for a longer duration and on consecutive days, effects could accrue to the point that reproductive success is jeopardized, although those sorts of impacts are not expected to result from these activities. Accordingly, in analyzing the number of takes and the likelihood of repeated and sequential takes, we consider the total takes, not just the takes by Level B harassment by behavioral disturbance, so that individuals potentially exposed to both threshold shift and behavioral disturbance are appropriately considered. The number of Level A harassment takes by PTS are so low (and zero in most cases) compared to abundance numbers that it is considered highly unlikely that any individual would be taken at those levels more than once.

Occasional, milder behavioral reactions are unlikely to cause long-term consequences for individual animals or populations, and even if some smaller subset of the takes are in the form of a longer (several hours or a day) and more severe response, if they are not expected to be repeated over sequential days, impacts to individual fitness are not anticipated. Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer *et al.,* 2018; Harris *et al.,* 2017; King *et al.,* 2015; NAS 2017; New *et al.,* 2014; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015).

If impacts to individuals are of a magnitude or severity such that either repeated and sequential higher severity impacts occur (the probability of this goes up for an individual the higher total number of takes it has) or the total number of moderate to more severe impacts increases substantially, especially if occurring across sequential days, then it becomes more likely that the aggregate effects could potentially interfere with feeding enough to reduce energy budgets in a manner that could impact reproductive success via longer cow-calf intervals, terminated pregnancies, or calf mortality. It is important to note that these impacts would only accrue to females, which only comprise a portion of the population (typically approximately 50 percent). Based on energetic models, it takes energetic impacts of a significantly greater magnitude to cause the death of an adult marine mammal, and females will always terminate a pregnancy or stop lactating before allowing their health to deteriorate. Also, the death of an adult female has significantly more impact on population growth rates than reductions in reproductive success, while the death of an adult male has very little effect on population growth rates. However, as will be explained further in the sections below, the severity and magnitude of takes expected to result from Navy activities in the TMAA are such that energetic impacts of a scale that might affect reproductive success are not expected to occur at all.

The analyses below in some cases address species collectively if they occupy the same functional hearing group (*i.e.,* low, mid, and high-frequency cetaceans), share similar life history strategies, and/or are known to behaviorally respond similarly to acoustic stressors. Because some of these groups or species share characteristics that inform the impact analysis similarly, it would be duplicative to repeat the same analysis for each species. In addition, similar species typically have the same hearing capabilities and behaviorally respond in the same manner.

Thus, our analysis below considers the effects of the Navy's activities on each affected species or stock even where discussion is organized by functional hearing group and/or information is evaluated at the group level. Where there are meaningful differences between a species or stock that would further differentiate the analysis, they are either described within the section or the discussion for those species or stocks is included as a separate subsection. Specifically below, we first provide broad discussion of the expected effects on the mysticete, odontocete, and pinniped groups generally, and then differentiate into further groups as appropriate.

Mysticetes

This section builds on the broader discussion above and brings together the discussion of the different types and amounts of take that different species and stocks would likely incur, the applicable mitigation, and the status of the species and stocks to support the preliminary negligible impact determinations for each species or stock. We have described (earlier in this section) the unlikelihood of any masking having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. We have also described above in the Potential Effects of Specified Activities on Marine Mammals and their Habitat section the unlikelihood of any habitat impacts having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. For mysticetes, there is no predicted non-auditory tissue damage from explosives for any species, and only two fin whales could be taken by PTS by exposure to in-air explosions at or above the water surface. Much of the discussion below focuses on the behavioral effects and the mitigation measures that reduce the probability or severity of effects. Because there are species-specific and stock-specific considerations, at the end of the section we break out our findings on a species-specific and, for one species, stock-specific basis.

In Table 41 below for mysticetes, we indicate for each species and stock the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 41—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR MYSTICETES AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take [1]			Total takes	Abundance (NMFS SARs) [2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
North Pacific right whale	Eastern North Pacific	1	2	0	3	31	9.7
Humpback whale	California, Oregon, & Washington.	2	8	0	10	4,973	<1
	Central North Pacific	11	68	0	79	10,103	<1
	Western North Pacific	[3] 3	0	0	[3] 3	1,107	<1
Blue whale	Central North Pacific	0	3	0	3	133	2.3
	Eastern North Pacific	4	32	0	36	1,898	1.9
Fin whale	Northeast Pacific	115	1,127	2	1,244	[4] 3,168	39.3
Sei whale	Eastern North Pacific	3	34	0	37	519	7.1
Minke whale	Alaska	6	44	0	50	[5] 389	12.9
Gray whale	Eastern North Pacific	[3] 4	0	0	[3] 4	26,960	<1

[1] Estimated impacts are based on the maximum number of activities in a given year under the specified activity. Not all takes represent separate individuals, especially for behavioral disturbance.

[2] Presented in the 2021 draft SARs or most recent SAR.

[3] The Navy's Acoustic Effects Model estimated zero takes for each of these stocks. However, NMFS conservatively proposes to authorize take by Level B harassment of one group of Western North Pacific humpback whale and one group of Eastern North Pacific gray whale. The annual take estimates reflect the average group sizes of on- and off-effort survey sightings of humpback whale and gray whale (excluding an outlier of an estimated 25 gray whales in one group) reported in Rone *et al.* (2017).

[4] The SAR reports this stock abundance assessment as provisional and notes that it is an underestimate for the entire stock because it is based on surveys which covered only a small portion of the stock's range.

[5] The 2018 final SAR (most recent SAR) for the Alaska stock of minke whales reports the stock abundance as unknown because only a portion of the stock's range has been surveyed. To be conservative, for this stock we report the smallest estimated abundance produced during recent surveys.

The majority of takes by harassment of mysticetes in the TMAA would be caused by anti-submarine warfare (ASW) activities. Anti-submarine activities include sources from the MFAS bin (which includes hull-mounted sonar). They are high level, narrowband sources in the 1–10 kHz range, which intersect what is estimated to be the most sensitive area of hearing for mysticetes. They also are used in a large portion of exercises (see Table 1 and Table 3). Most of the takes (88 percent) from the MF1 bin in the TMAA would result from received levels between 166 and 178 dB SPL, while another 11 percent would result from exposure between 160 and 166 dB SPL. For the remaining active sonar bin types, the percentages are as follows: MF4 = 97 percent between 142 and 154 dB SPL and MF5 = 97 percent between 118 and 142 dB SPL. For mysticetes, exposure to explosives would result in comparatively smaller numbers of takes by Level B harassment by behavioral disturbance (0–11 per stock) and TTS takes (0–2 per stock). Based on this information, the majority of the takes by Level B harassment by behavioral disturbance would be expected to be of low to sometimes moderate severity and of a relatively shorter duration. Exposure to explosives would also result in two takes by Level A harassment by PTS of the Northeast Pacific stock of fin whale. No mortality or serious injury and no Level A harassment from non-auditory tissue damage from training activities is anticipated or proposed for authorization for any species or stock.

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 feeding or breeding grounds. Behavioral reactions may include alerting, breaking off feeding dives and surfacing, diving or swimming away, or no response at all (DOD, 2017; Nowacek, 2007; Richardson, 1995; Southall *et al.,* 2007). Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise source is located directly on their migration route. Mysticetes disturbed while migrating could pause their migration or route around the disturbance, while males en route to breeding grounds have been shown to be less responsive to disturbances. Although some may pause temporarily, they would resume migration shortly after the exposure ends. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Alternately, adult females with calves may be more responsive to stressors.

As noted in the Potential Effects of Specified Activities on Marine Mammals and Their Habitat section, while there are multiple examples from behavioral response studies of odontocetes ceasing their feeding dives when exposed to sonar pulses at certain levels, blue whales were less likely to show a visible response to sonar exposures at certain levels when feeding than when traveling. However, Goldbogen *et al.* (2013) indicated some horizontal displacement of deep foraging blue whales in response to simulated MFAS. Southall *et al.* (2019b) observed that after exposure to simulated and operational mid-frequency active sonar, more than 50 percent of blue whales in deep-diving states responded to the sonar, while no behavioral response was observed in shallow-feeding blue whales. Southall *et al.* (2019b) noted that the behavioral responses they observed were generally brief, of low to moderate severity, and highly dependent on exposure context (behavioral state, source-to-whale horizontal range, and prey availability).

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. Some mysticetes may avoid larger activities as they move through an area, although the Navy's activities do not typically use the same training locations day-after-day during multi-day activities, except periodically in instrumented ranges, which are not present in the GOA Study Area. Therefore, displaced animals could return quickly after even a large activity or MTE is completed.

At most, only one MTE would occur per year (over a maximum of 21 days), and additionally, MF1 mid-frequency active sonar would be prohibited from June 1 to September 30 within the North Pacific Right Whale Mitigation Area. Explosives detonated below 10,000 ft. altitude (including at the water surface) would be prohibited in the Continental Shelf and Slope Mitigation Area, including in the portion that overlaps the North Pacific Right Whale Mitigation Area. In the open waters of the Gulf of Alaska, the use of Navy sonar and other active acoustic sources is transient and would be unlikely to expose the same population of animals repeatedly over a short period of time, especially given the broader-scale movements of mysticetes and the 21-day duration of the activities.

The implementation of procedural mitigation and the sightability of mysticetes (due to their large size) would further reduce the potential for a significant behavioral reaction or a threshold shift to occur (*i.e.,* shutdowns are expected to be successfully implemented), which is reflected in the amount and type of incidental take that would be anticipated to occur and is proposed for authorization. Level B harassment by behavioral disturbance of mysticetes resulting from the TMAA activities would likely be short-term and of low to sometimes moderate severity, with no anticipated effect on reproduction or survival of any individuals.

As noted previously, when an animal incurs a threshold shift, it occurs in the frequency from that of the source up to one octave above. This means that the vast majority of threshold shifts caused by Navy sonar sources would typically occur in the range of 2–20 kHz (from the 1–10 kHz MF bin, though in a specific narrow band within this range as the sources are narrowband), and if resulting from hull-mounted sonar, would be in the range of 3.5–7 kHz. The majority of mysticete vocalizations occur in frequencies below 1 kHz, which means that TTS incurred by mysticetes would not interfere with conspecific communication. Additionally, many of the other critical sounds that serve as cues for navigation and prey (*e.g.,* waves, fish, invertebrates) occur below a few kHz, which means that detection of these signals would not be inhibited by most threshold shift either. When we look in ocean areas where the Navy has been intensively training and testing with sonar and other active acoustic sources for decades, there is no data suggesting any long-term consequences to reproduction or survival rates of mysticetes from exposure to sonar and other active acoustic sources.

All the mysticete species discussed in this section would benefit from the procedural mitigation measures described earlier in the Proposed Mitigation Measures section. Additionally, the Navy would issue awareness messages prior to the start of TMAA training activities to alert vessels and aircraft operating within the TMAA to the possible presence of concentrations of large whales, including mysticetes, especially when traversing on the continental shelf and slope where densities of these species may be higher. To maintain safety of navigation and to avoid interactions with marine mammals, the Navy would instruct vessels to remain vigilant to the presence of large whales that may be vulnerable to vessel strikes or potential impacts from training activities. Further, the Navy would limit activities and employ other measures in mitigation areas that would avoid or reduce impacts to mysticetes. Where these mitigation areas are expected to mitigate impacts to particular species or stocks (North Pacific right whale, humpback whale, gray whale), they are discussed in detail below. Below we compile and summarize the information that supports our preliminary determinations that the Navy's activities would not adversely affect any mysticete species or stock through effects on annual rates of recruitment or survival.

North Pacific Right Whale (Eastern North Pacific Stock)

North Pacific right whales are listed as endangered under the ESA, and this species is currently one of the most endangered whales in the world (Clapham, 2016; NMFS, 2013, 2017; Wade *et al.,* 2010). The current population trend is unknown. ESA-designated critical habitat for the North Pacific right whale is located in the western Gulf of Alaska off Kodiak Island and in the southeastern Bering Sea/Bristol Bay area (Muto *et al.,* 2017; Muto *et al.,* 2018b; Muto *et al.,* 2020a); there is no designated critical habitat for this species within the GOA Study Area. North Pacific right whales are anticipated to be present in the GOA Study Area year round, but are considered rare, with a potentially higher density between June and September. A BIA for feeding (June through September; Ferguson *et al.,* 2015b) overlaps with the TMAA portion of the GOA Study Area by approximately 2,051 km^2 (approximately 7 percent of the feeding BIA and 1.4 percent of the TMAA). This BIA does not overlap with any portion of the WMA. This proposed rule includes a North Pacific Right Whale Mitigation Area and Continental Shelf and Slope Mitigation Area, which both overlap with the portion of the North Pacific right whale feeding BIA that overlaps with the TMAA. From June 1 to September 30, Navy personnel will not use surface ship hull-mounted MF1 mid-frequency active sonar during training activities within the North Pacific Right Whale Mitigation Area. Further, Navy personnel will not detonate explosives below 10,000 ft altitude (including at the water surface) during training at all times in the Continental Shelf and Slope Mitigation Area (including in the portion that overlaps the North Pacific Right Whale Mitigation Area). These restrictions would reduce the severity of impacts to North Pacific right whales by reducing interference in feeding that could result in lost feeding opportunities or necessitate additional energy expenditure to find other good foraging opportunities.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), only 3 instances of take by level B harassment (2 TTS, and 1 behavioral disturbance) are estimated, which equate to about 10 percent of the very small estimated abundance. Given this very small estimate, repeated exposures of individuals are not anticipated. Regarding the severity of individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with North Pacific right whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, North Pacific right whales are listed as endangered under the ESA, and the current population trend is unknown. Only three instances of take are estimated to occur (a small portion of the stock), and any individual North Pacific right whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Eastern North Pacific stock of North Pacific right whales.

Humpback Whale (California/Oregon/Washington Stock)

The California/Oregon/Washington (CA/OR/WA) stock of humpback whales includes individuals from three ESA DPSs: Central America (endangered), Mexico (threatened), and Hawaii (not listed). A small portion of ESA-designated critical habitat overlaps with the TMAA portion of the GOA Study Area (see Figure 4–1 of the Navy's rulemaking/LOA application). The ESA-designated critical habitat does not overlap with any portion of the WMA. No other BIAs are identified for this species in the GOA Study Area. The SAR identifies this stock as stable (having shown a long-term increase from 1990 and then leveling off between 2008 and 2014). Navy personnel will not use surface ship hull-mounted MF1 mid-frequency active sonar from June 1 to September 30 within the North Pacific Right Whale Mitigation Area, which overlaps 18 percent of the humpback whale critical habitat in the TMAA. Further, Navy personnel will not detonate explosives below 10,000 ft altitude (including at the water surface) during training at all times in the Continental Shelf and Slope Mitigation Area (including in the portion that overlaps the North Pacific Right Whale Mitigation Area), which fully overlaps the portion of the humpback whale critical habitat in the TMAA. These measures would reduce the severity of impacts to humpback whales by reducing interference in feeding that could result in lost feeding opportunities or necessitate additional energy expenditure to find other good opportunities.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take is 10 (8 TTS and 2 behavioral disturbance), which is less than 1 percent of the abundance. Given the very low number of anticipated instances of take, only a very small portion of individuals in the stock are likely impacted and repeated exposures of individuals are not anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with humpback whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, this population is stable (even though two of the three associated DPSs are listed as endangered or threatened under the ESA), only a very small portion of the stock is anticipated to be impacted, and any individual humpback whale is likely to be disturbed at a low-moderate level. No mortality or serious injury and no Level A harassment is anticipated or proposed to be authorized. This low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the CA/OR/WA stock of humpback whales.

Humpback Whale (Central North Pacific Stock)

The Central North Pacific stock of humpback whales consists of winter/spring humpback whale populations of the Hawaiian Islands which migrate primarily to foraging habitat in northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands. The population is increasing (Muto *et al.* 2020), the Hawaii DPS is not ESA-listed, and no BIAs have been identified for this species in the GOA Study Area. Navy personnel will not use surface ship hull-mounted MF1 mid-frequency active sonar from June 1 to September 30 within the North Pacific Right Whale Mitigation Area, which overlaps 18 percent of the humpback whale critical habitat within the TMAA. As noted above, the Hawaii DPS is not ESA-listed; however, this ESA-designated critical habitat still indicates the likely value of habitat in this area to non-listed humpback whales. Further, Navy personnel will not detonate explosives below 10,000 ft altitude (including at the water surface) during training at all times in the Continental Shelf and Slope Mitigation Area (including in the portion that overlaps the North Pacific Right Whale Mitigation Area), which fully overlaps the portion of the humpback whale critical habitat in the TMAA. These measures would reduce the severity of impacts to humpback whales by reducing interference in feeding that could result in lost feeding opportunities or necessitate additional energy expenditure to find other good opportunities.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated instances of take compared to the abundance is less than 1 percent. This information and the complicated far-ranging nature of the stock structure indicates that only a very small portion of the stock is likely impacted. While no BIAs have been identified in the GOA Study Area, highest densities in the nearby Kodiak Island feeding BIA (July to September) and Prince William Sound feeding BIA (September to December) overlap with much of the potential window for the Navy's exercise in the GOA Study Area (April to October). Given that some whales may remain in the area surrounding these BIAs for some time to feed during the Navy's exercise, there may be a few repeated exposures of a few individuals, most likely on non-sequential days. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with humpback whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, this population is increasing and the associated DPS is not listed as endangered or threatened under the ESA. Only a very small portion of the stock is anticipated to be impacted and any individual humpback whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Central North Pacific stock of humpback whales.

Humpback Whale (Western North Pacific Stock)

The Western North Pacific stock of humpback whales includes individuals from the Western North Pacific DPS, which is ESA-listed as endangered. A relatively small portion of ESA-designated critical habitat overlaps with the TMAA (2,708 km^2 (1,046 mi^2) of critical habitat Unit 5, 5,991 km^2 (2,313 mi^2) of critical habitat Unit 8; see Figure 4–1 of the Navy's rulemaking/LOA application). The ESA-designated critical habitat does not overlap with any portion of the WMA. No other BIAs are identified for this species in the GOA Study Area. The current population trend for this stock is unknown. Navy personnel will not use surface ship hull-mounted MF1 mid-frequency active sonar from June 1 to September 30 within the North Pacific Right Whale Mitigation Area, which overlaps 18 percent of the humpback whale critical habitat within the TMAA. Further, Navy personnel will not detonate explosives below 10,000 ft altitude (including at the water surface) during training at all times in the Continental Shelf and Slope Mitigation Area (including in the portion that overlaps the North Pacific Right Whale Mitigation Area), which fully overlaps the portion of the humpback whale critical habitat in the TMAA. These measures would reduce the severity of impacts to humpback whales by reducing interference in feeding that could result in lost feeding opportunities or necessitate additional energy expenditure to find other good opportunities.

Regarding the magnitude of takes by Level B harassment (behavioral disturbance only), the number of estimated total instances of take is three, which is less than 1 percent of the abundance. Given the very low number of anticipated instances of take, only a very small portion of individuals in the stock are likely impacted and repeated exposures of individuals are not anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level).

Altogether, the status of this stock is unknown, only a very small portion of the stock is anticipated to be impacted (3 individuals), and any individual humpback whale is likely to be disturbed at a low-moderate level. No mortality, serious injury, Level A harassment, or TTS is anticipated or proposed to be authorized. This low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Western North Pacific stock of humpback whales.

Blue Whale (Central North Pacific Stock and Eastern North Pacific Stock)

Blue whales are listed as endangered under the ESA throughout their range, but there is no ESA designated critical habitat and no BIAs have been identified for this species in the GOA Study Area. The current population trend for the Central North Pacific stock is unknown, and the Eastern North Pacific stock is stable.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 2 percent for both the Central North Pacific stock, and the Eastern North Pacific stock. For the Central North Pacific stock, only 3 instances of take (TTS) are anticipated.

Given the range of both blue whale stocks, the absence of any known feeding or aggregation areas, and the very low number of anticipated instances of take of the Central North Pacific stock, this information indicates that only a small portion of individuals in the stock are likely impacted and repeated exposures of individuals are not anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, we have explained that they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with blue whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, blue whales are listed as endangered under the ESA throughout their range, the current population trend for the Central North Pacific stock is unknown, and the Eastern North Pacific stock is stable. Only a small portion of the stocks are anticipated to be impacted, and any individual blue whale is likely to be disturbed at a low-moderate level. The low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality and no Level A harassment is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Central North Pacific stock and the Eastern North Pacific stock of blue whales.

Fin Whale (Northeast Pacific Stock)

Fin whales are listed as endangered under the ESA throughout their range, but there is no ESA designated critical habitat and no BIAs have been identified for this species in the GOA Study Area. The SAR identifies this stock as increasing.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 39 percent (though, as noted in Table 41, the SAR reports the stock abundance assessment as provisional and notes that it is an underestimate for the entire stock because it is based on surveys which covered only a small portion of the stock's range, and therefore 39 percent is likely an overestimate). Given the large range of the stock and short duration of the Navy's activities in the GOA Study Area, this information suggests that notably fewer than half of the individuals of the stock would likely be impacted, and that most affected individuals would likely be disturbed on a few days within the 21-day exercise, with the days most likely being non-sequential. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with fin whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

For these same reasons (low level and frequency band), while a small permanent loss of hearing sensitivity (PTS) may include some degree of energetic costs for compensating or may mean some small loss of opportunities or detection capabilities, at the expected scale the estimated two takes by Level A harassment by PTS would be unlikely to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival of those individuals. Thus, the two takes by Level A harassment by PTS would be unlikely to affect rates of recruitment and survival for the stock.

Altogether, fin whales are listed as endangered under the ESA, though this population is increasing. Only a small portion of the stock is anticipated to be impacted, and any individual fin whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury and no Level A harassment from non-auditory tissue damage is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Northeast Pacific stock of fin whales.

Sei Whale (Eastern North Pacific Stock)

The population trend of this stock is unknown, however sei whales are listed as endangered under the ESA throughout their range. There is no ESA designated critical habitat and no BIAs have been identified for this species in the GOA Study Area.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 7 percent. This information and the rare occurrence of sei whales in the TMAA suggests that only a small portion of individuals in the stock would likely be impacted and repeated exposures of individuals would not be anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with sei whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, the status of the stock is unknown and the species is listed as endangered, only a small portion of the stock is anticipated to be impacted, and any individual sei whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on individual reproduction or survival, much less annual rates of recruitment or survival. No mortality and no Level A harassment is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Eastern North Pacific stock of sei whales.

Minke Whale (Alaska Stock)

The status of this stock is unknown and the species is not listed under the ESA. No BIAs have been identified for this species in the GOA Study Area.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 13 percent for the Alaska stock (based on, to be conservative, the smallest available provisional estimate in the SAR, which is derived from surveys that cover only a portion of the stock's range). Given the range of the Alaska stock of minke whales, this information indicates that only a small portion of individuals in this stock are likely to be impacted and repeated exposures of individuals are not anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with minke whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, although the status of the stock is unknown, the species is not listed under the ESA as endangered or threatened, only a small portion of the stock is anticipated to be impacted, and any individual minke whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Alaska stock of minke whales.

Gray Whale (Eastern North Pacific Stock)

The Eastern North Pacific stock of gray whale is not ESA-listed, and the SAR indicates that the stock is increasing. The TMAA portion of the GOA Study Area overlaps with a gray whale migration corridor that has been identified as a BIA (November–January (outside of the potential training window), southbound; March–May, northbound; Ferguson *et al.,* 2015). The WMA portion of the GOA Study Area does not overlap with any known important areas for gray whales.

Regarding the magnitude of takes by Level B harassment (behavioral disturbance only), the number of estimated total instances of take is four, which is less than 1 percent of the abundance. Given the very low number of anticipated instances of take, only a very small portion of individuals in the stock are likely impacted and repeated exposures of individuals are not anticipated. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB with a small portion up to 184 dB (*i.e.,* of a moderate or sometimes lower level).

Altogether, while we have considered the impacts of the gray whale UME, this population of gray whales is not endangered or threatened under the ESA, and the stock is increasing. No mortality, Level A harassment, or TTS is anticipated or proposed to be authorized. Only a very small portion of the stock is anticipated to be impacted, and any individual gray whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Eastern North Pacific stock of gray whales.

Odontocetes

This section builds on the broader discussion above and brings together the discussion of the different types and amounts of take that different species and stocks would likely incur, the applicable mitigation, and the status of the species and stocks to support the negligible impact determinations for each species or stock. We have described (earlier in this section) the unlikelihood of any masking having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. We have also described above in the Potential Effects of Specified Activities on Marine Mammals and their Habitat section the unlikelihood of any habitat impacts having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. There is no predicted PTS from sonar or explosives for most odontocetes, with the exception of Dall's porpoise, which is discussed below. There is no anticipated M/SI or non-auditory tissue damage from sonar or explosives for any species. Here, we include information that applies to all of the odontocete species, which are then further divided and discussed in more detail in the following subsections: sperm whales; beaked whales; dolphins and small whales; and porpoises. These subsections include more specific information about the groups, as well as conclusions for each species or stock represented.

The majority of takes by harassment of odontocetes in the TMAA are caused by sources from the MFAS bin (which includes hull-mounted sonar) because they are high level, typically narrowband sources at a frequency (in the 1–10 kHz range) that overlaps a more sensitive portion (though not the most sensitive) of the MF hearing range and they are used in a large portion of exercises (see Table 1 and Table 3). For odontocetes other than beaked whales (for which these percentages are indicated separately in that section), most of the takes (95 percent) from the MF1 bin in the TMAA would result from received levels between 160 and 172 dB SPL. For the remaining active sonar bin types, the percentages are as follows: MF4 = 98 percent between 142 and 160 dB SPL and MF5 = 94 percent between 118 and 142 dB SPL. Based on this information, the majority of the takes by Level B harassment by behavioral disturbance are expected to be low to sometimes moderate in nature, but still of a generally shorter duration.

For all odontocetes, takes from explosives (Level B harassment by behavioral disturbance, TTS, or PTS) comprise a very small fraction (and low number) of those caused by exposure to active sonar. For the following odontocetes, zero takes from explosives are expected to occur: sperm whale, killer whale, Pacific white-sided dolphin, Baird's beaked whale, and Stejneger's beaked whale. For Level B harassment by behavioral disturbance from explosives, one take is anticipated for Cuvier's beaked whale and 38 takes are anticipated for Dall's porpoise. No TTS or PTS is expected to occur from explosives for any stocks except Dall's porpoise. Because of the lower TTS and PTS thresholds for HF odontocetes, the Alaska stock of Dall's porpoise is expected to have 229 takes by TTS and 45 takes by PTS from explosives.

Because the majority of harassment takes of odontocetes result from the sources in the MFAS bin, the vast majority of threshold shift would occur at a single frequency within the 1–10 kHz range and, therefore, the vast majority of threshold shift caused by Navy sonar sources would be at a single frequency within the range of 2–20 kHz. The frequency range within which any of the anticipated narrowband threshold shift would occur would fall directly within the range of most odontocete vocalizations (2–20 kHz) (though phocoenids generally communicate at higher frequencies (Soerensen *et al.,* 2018; Clausen *et al.* 2010), which would not be impacted by this threshold shift). For example, the most commonly used hull-mounted sonar has a frequency around 3.5 kHz, and any associated threshold shift would be expected to be at around 7 kHz. However, odontocete vocalizations typically span a much wider range than this, and alternately, threshold shift from active sonar will often be in a narrower band (reflecting the narrower band source that caused it), which means that TTS incurred by odontocetes would typically only interfere with communication within a portion of their hearing range (if it occurred during a time when communication with conspecifics was occurring) and, as discussed earlier, it would only be expected to be of a short duration and relatively small degree. Odontocete echolocation occurs predominantly at frequencies significantly higher than 20 kHz (though there may be some small overlap at the lower part of their echolocating range for some species), which means that there is little likelihood that threshold shift, either temporary or permanent, would interfere with feeding behaviors.

Many of the other critical sounds that serve as cues for navigation and prey (*e.g.,* waves, fish, invertebrates) occur below a few kHz, which means that detection of these signals will not be inhibited by most threshold shift either. The low number of takes by threshold shift that might be incurred by individuals exposed to explosives would likely be lower frequency (5 kHz or less) and spanning a wider frequency range, which could slightly lower an individual's sensitivity to navigational or prey cues, or a small portion of communication calls, for several minutes to hours (if temporary) or permanently. There is no reason to think that the vast majority of the individual odontocetes taken by TTS would incur TTS on more than one day, although a small number could incur TTS on a few days at most. Therefore, odontocetes are unlikely to incur impacts on reproduction or survival as a result of TTS. PTS takes from these sources are very low (0 for all species other than Dall's porpoise), and while spanning a wider frequency band, are still expected to be of a low degree (*i.e.,* low amount of hearing sensitivity loss) and unlikely to affect reproduction or survival.

The range of potential behavioral effects of sound exposure on marine mammals generally, and odontocetes specifically, has been discussed in detail previously. There are behavioral patterns that differentiate the likely impacts on odontocetes as compared to mysticetes however. First, odontocetes echolocate to find prey, which means that they actively send out sounds to detect their prey. While there are many strategies for hunting, one common pattern, especially for deeper diving species, is many repeated deep dives within a bout, and multiple bouts within a day, to find and catch prey. As discussed above, studies demonstrate that odontocetes may cease their foraging dives in response to sound exposure. If enough foraging interruptions occur over multiple sequential days, and the individual either does not take in the necessary food, or must exert significant effort to find necessary food elsewhere, energy budget deficits can occur that could potentially result in impacts to reproductive success, such as increased cow/calf intervals (the time between successive calving). However, the relatively low impact of the Navy's activities on odontocetes in the TMAA indicate this is not likely to occur. Second, while many mysticetes rely on seasonal migratory patterns that position them in a geographic location at a specific time of the year to take advantage of ephemeral large abundances of prey (*i.e.,* invertebrates or small fish, which they eat by the thousands), odontocetes forage more homogeneously on one fish or squid at a time. Therefore, if odontocetes are interrupted while feeding, it is often possible to find more prey relatively nearby.

All the odontocete species and stocks discussed in this section would benefit from the procedural mitigation measures described earlier in the Proposed Mitigation Measures section.

Sperm Whale (North Pacific Stock)

This section builds on the broader odontocete discussion above and brings together the discussion of the different types and amounts of take that sperm whales would likely incur, the applicable mitigation, and the status of the species/stock to support the preliminary negligible impact determination for the stock.

Sperm whales are listed as endangered under the ESA. No critical habitat has been designated for sperm whales under the ESA and no BIAs for sperm whales have been identified in the GOA Study Area. The stock's current population trend is unknown. The Navy would issue awareness messages prior to the start of TMAA training activities to alert Navy ships and aircraft operating within the TMAA to the possible presence of increased concentrations of large whales, including sperm whales. This measure would further reduce any possibility of ship strike of sperm whales.

In Table 42 below for sperm whales, we indicate the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 42—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR SPERM WHALES IN THE TMAA AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take[1]			Total takes	Abundance (NMFS SARs)[2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
Sperm whale	North Pacific	107	5	0	112	[3] 345	32.5

[1] Estimated impacts are based on the maximum number of activities in a given year under the specified activity. Not all takes represent separate individuals, especially for disturbance.
[2] Presented in the 2021 draft SARs or most recent SAR.
[3] The SAR reports that this is an underestimate for the entire stock because it is based on surveys of a small portion of the stock's extensive range and it does not account for animals missed on the trackline or for females and juveniles in tropical and subtropical waters.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 33 percent. Given the range of this stock, this information indicates that fewer than half of the individuals in the stock are likely to be impacted, with those individuals disturbed on likely one, but not more than a few non-sequential days within the 21 days per year. Additionally, while interrupted feeding bouts are a known response and concern for odontocetes, we also know that there are often viable alternative habitat options in the relative vicinity. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB (*i.e.,* of a lower, to occasionally moderate, level and less likely to evoke a severe response). As discussed earlier in the Preliminary Analysis and Negligible Impact Determination section, we anticipate more severe effects from takes when animals are exposed to higher received levels or for longer durations. Occasional milder Level B harassment by behavioral disturbance, as is expected here, is unlikely to cause long-term consequences for either individual animals or populations, even if some smaller subset of the takes are in the form of a longer (several hours or a day) and more moderate response. Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with sperm whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, sperm whales are listed as endangered under the ESA, and the current population trend is unknown. Fewer than half of the individuals of the stock are anticipated to be impacted, and any individual sperm whale is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on reproduction or survival for any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the North Pacific stock of sperm whales.

Beaked Whales

This section builds on the broader odontocete discussion above and brings together the discussion of the different types and amounts of take that different beaked whale species and stocks would likely incur, the applicable mitigation, and the status of the species and stocks to support the preliminary negligible impact determinations for each species or stock. For beaked whales, no mortality or Level A harassment is anticipated or proposed for authorization.

In Table 43 below for beaked whales, we indicate the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 43—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR BEAKED WHALES IN THE TMAA AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take[1]			Total takes	Abundance (NMFS SARs)[2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
Baird's beaked whale	Alaska	106	0	0	106	NA	NA
Cuvier's beaked whale	Alaska	430	3	0	433	NA	NA
Stejneger's beaked whale	Alaska	467	15	0	482	NA	NA

[1] Estimated impacts are based on the maximum number of activities in a given year under the specified activity. Not all takes represent separate individuals, especially for disturbance.
[2] Reliable estimates of abundance for these stocks are currently unavailable.

This first paragraph provides specific information that is in lieu of the parallel information provided for odontocetes as a whole. The majority of takes by harassment of beaked whales in the TMAA would be caused by sources from the MFAS bin (which includes hull-mounted sonar) because they are high level narrowband sources that fall within the 1–10 kHz range, which overlap a more sensitive portion (though not the most sensitive) of the MF hearing range. Also, of the sources expected to result in take, they are used in a large portion of exercises (see Table 1 and Table 3). Most of the takes (98 percent) from the MF1 bin in the TMAA would result from received levels between 148 and 166 dB SPL. For the remaining active sonar bin types, the percentages are as follows: MF4 = 97 percent between 130 and 148 dB SPL and MF5 = 99 percent between 100 and 148 dB SPL. Given the levels they are exposed to and beaked whale sensitivity, some responses would be of a lower severity, but many would likely be considered moderate, but still of generally short duration.

Research has shown that beaked whales are especially sensitive to the presence of human activity (Pirotta *et al.,* 2012; Tyack *et al.,* 2011) and therefore have been assigned a lower harassment threshold, with lower received levels resulting in a higher percentage of individuals being harassed and a more distant distance cutoff (50 km for high source level, 25 km for moderate source level).

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). Available information suggests that beaked whales likely have enhanced sensitivity to sonar sound, given documented incidents of stranding in conjunction with specific circumstances of MFAS use, although few definitive causal relationships between MFAS use and strandings have been documented (see Potential Effects of Specified Activities on Marine Mammals and their Habitat section). NMFS neither anticipates nor proposes to authorize the mortality of beaked whales (or any other species or stocks) resulting from exposure to active sonar.

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). For example, after being exposed to 1–2 kHz upsweep naval sonar signals at a received SPL of 107 dB re 1 μPa, Northern bottlenose whales began moving in an unusually straight course, made a near 180° turn away from the source, and performed the longest and deepest dive (94 min, 2339 m) recorded for this species (Miller *et al.,* 2015). Wensveen *et al.* (2019) also documented avoidance behaviors in Northern bottlenose whales exposed to 1–2 kHz tonal sonar signals with SPLs ranging between 117–126 dB re: 1 μPa, including interrupted diving behaviors, elevated swim speeds, directed movements away from the sound source, and cessation of acoustic signals throughout exposure periods. 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: 1 µPa. 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. 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; McCarthy *et al.,* 2011; Moretti *et al.,* 2009, 2010; Tyack *et al.,* 2010, 2011). Joyce *et al.* (2019) found that Blainville's beaked whales moved up to 68 km away from an Atlantic Undersea Test and Evaluation Center site and reduced time spent on deep dives after the onset of mid-frequency active sonar exposure; whales did not return to the site until 2–4 days after the exercises ended. Changes in acoustic activity have also been documented. For example, Blainville's beaked whales showed decreased group vocal periods after biannual multi-day Navy training activities (Henderson *et al.,* 2016). Tyack *et al.* (2011) reported 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. Falcone *et al.* (2017) however, documented that Cuvier's beaked whales had longer dives and surface durations after exposure to mid-frequency active sonar, with the longer surface intervals contributing to a longer interval between deep dives, a proxy for foraging disruption in this species. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure 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 most likely in cases where 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 (De Ruiter *et al.,* 2013; Manzano-Roth *et al.,* 2013; Moretti *et al.,* 2014; Tyack *et al.,* 2011). 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, have identified approximately 100 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. More than 8 years of passive acoustic monitoring on the Navy's instrumented range west of San Clemente Island documented no significant changes in annual and monthly beaked whale echolocation clicks, with the exception of repeated fall declines likely driven by natural beaked whale life history functions (DiMarzio *et al.,* 2018). Finally, results from passive acoustic monitoring estimated that regional Cuvier's beaked whale densities were higher than indicated by NMFS' broad scale visual surveys for the United States West Coast (Hildebrand and McDonald, 2009).

Below we compile and summarize the information that supports our preliminary determinations that the Navy's activities would not adversely affect any of the beaked whale stocks through effects on annual rates of recruitment or survival. Baird's, Cuvier's, and Stejneger's beaked whales (Alaska stocks)

Baird's beaked whale, Cuvier's beaked whale, and Stejneger's beaked whale are not listed as endangered or threatened species under the ESA, and the 2019 Alaska SARs indicate that trend information is not available for any of the Alaska stocks. No BIAs for beaked whales have been identified in the GOA Study Area.

As indicated in Table 43, no abundance estimates are available for any of the stocks. However, the ranges of all three stocks are large compared to the GOA Study Area (Cuvier's is the smallest, occupying all of the Gulf of Alaska, south of the Canadian border and west along the Aleutian Islands. Baird's range even farther south and Baird's and Stejneger's also cross north over the Aleutian Islands).

Regarding abundance and distribution of these species in the vicinity of the TMAA, passive acoustic data indicate spatial overlap of all three beaked whales; however, detections are spatially offset, suggesting some level of habitat portioning in the Gulf of Alaska (Rice *et al.,* 2021). Peaks in detections by Rice *et al.* (2021) were also temporally offset, with detections of Baird's beaked whale clicks peaking in winter at the slope and in spring at the seamounts. Rice *et al.* (2021) indicates Baird's beaked whales were highest in number at Quinn seamount, which overlaps with the southern edge of the TMAA, and therefore, a portion of this habitat is outside of the TMAA. Baumann Pickering *et al.* (2012b) did not acoustically detect Baird's beaked whales from July-October in the northern Gulf of Alaska (overlapping with the majority of the Navy's potential training period), while acoustic detections from November-January suggest that Baird's beaked whales may winter in this area. Rice *et al.* (2021) reported the highest detections of Baird's beaked whales within the TMAA during the spring in the portion of the TMAA that is farther offshore, with lowest detections in the summer and an increase in detections on the continental slope in the winter, indicating that the whales are either not producing clicks in the summer or they are migrating farther north or south to feed or mate during this time.

Data from a satellite-tagged Baird's beaked whale off Southern California recently documented movement north along the shelf-edge for more than 400 nmi over a six-and-a-half-day period (Schorr *et. al.,* Unpublished). If that example is reflective of more general behavior, Baird's beaked whales present in the TMAA may have much larger home ranges than the waters bounded by the TMAA, reducing the potential for repeated takes of individuals.

Regarding Stejneger's beaked whale, passive acoustic monitoring detected the whales most commonly at the slope and offshore in the TMAA (Rice *et al.,* 2021; Rice *et al.,* 2018b; Rice *et al.,* 2020b). At the slope, Stejneger's beaked whale detections peaked in fall (Rice *et al.,* 2021). Rice *et al.* (2021) notes that to date, there have been no documented sightings of Stejneger's beaked whales that were simultaneous with recording of vocalizations, which is necessary to confirm the vocalizations were produced by the species, and therefore, detections should be interpreted with caution. Baumann-Pickering *et al.* (2012b) recorded acoustic signals believed to be produced by Stejneger's beaked whales (based on frequency characteristics, interpulse interval, and geographic location; Baumann-Pickering *et al.,* 2012a) almost weekly from July 2011 to February 2012 in the northern Gulf of Alaska.

Regarding Cuvier's beaked whale, passive acoustic monitoring at five sites in the TMAA (Rice *et al.,* 2021; Rice *et al.,* 2015; Rice *et al.,* 2018b; Rice *et al.,* 2020a) has intermittently detected Cuvier's beaked whale vocalizations in low numbers in every month except April, although there are generally multiple months in any given year where no detections are made.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the anticipated takes would occur within a small portion of the stocks' ranges (including that none of the stocks are expected to occur in the far western edge of the TMAA; U.S. Department of the Navy, 2021) and would occur within the 21-day window of the annual activities. In consideration of these factors and the passive acoustic monitoring data described in this section, which indicates relatively low beaked whale presence in the TMAA during the Navy's potential training period, it is likely that a portion of the stocks would be taken, and a subset of them may be taken on a few days, with no indication that these days would be sequential.

Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 166 dB, though with beaked whales, which are considered somewhat more sensitive, this could mean that some individuals would leave preferred habitat for a day (*i.e.,* moderate level takes). However, while interrupted feeding bouts are a known response and concern for odontocetes, we also know that there are often viable alternative habitat options nearby. Regarding the severity of TTS takes (anticipated for Cuvier's and Stejneger's beaked whales only), they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with beaked whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival. As mentioned earlier in the odontocete overview, we anticipate more severe effects from takes when animals are exposed to higher received levels or sequential days of impacts.

Altogether, none of these species are ESA-listed, only a portion of the stocks are anticipated to be impacted, and any individual beaked whale is likely to be disturbed at a moderate or sometimes low level. This low magnitude and moderate to lower severity of harassment effects is not expected to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Alaska stocks of beaked whales.

Dolphins and Small Whales

This section builds on the broader odontocete discussion above and brings together the discussion of the different types and amounts of take that different dolphin and small whale species and stocks would likely incur, the applicable mitigation, and the status of the species and stocks to support the preliminary negligible impact determinations for each species or stock. For all dolphin and small whale stocks discussed here, no mortality or Level A harassment is anticipated or proposed for authorization.

In Table 44 below for dolphins and small whales, we indicate the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 44—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR DOLPHINS AND SMALL WHALES IN THE TMAA AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take [1]			Total takes	Abundance (NMFS SARs) [2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
Killer whale	Eastern North Pacific Offshore.	64	17	0	81	300	27.0
	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient.	119	24	0	143	587	24.4
Pacific white-sided dolphins	North Pacific	1,102	472	0	1,574	26,880	5.9

[1] Estimated impacts are based on the maximum number of activities in a given year under the specified activity. Not all takes represent separate individuals, especially for disturbance.

[2] Presented in the 2021 draft SARs or most recent SAR.

As described above, the large majority of Level B harassment by behavioral disturbance to odontocetes, and thereby dolphins and small whales, from hull-mounted sonar (MFAS) in the TMAA would result from received levels between 160 and 172 dB SPL. Therefore, the majority of takes by Level B harassment are expected to be in the form of low to occasionally moderate responses of a generally shorter duration. As mentioned earlier in this section, we anticipate more severe effects from takes when animals are exposed to higher received levels or for longer durations. Occasional milder occurrences of Level B harassment by behavioral disturbance are unlikely to cause long-term consequences for individual animals, much less have any effect on annual rates of recruitment or survival. No mortality, serious injury, or Level A harassment is expected or proposed for authorization.

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. Some dolphin species (the more surface-dwelling taxa—typically those with ''dolphin'' in the common name, such as bottlenose dolphins, spotted dolphins, spinner dolphins, rough-toothed dolphins, *etc.,* but not Risso's dolphin), especially those residing in more industrialized or busy areas, have demonstrated more tolerance for disturbance and loud sounds and many of these species are known to approach vessels to bow-ride. These species are often considered generally less sensitive to disturbance. Dolphins and small whales that reside in deeper waters and generally have fewer interactions with human activities are more likely to demonstrate more typical avoidance reactions and foraging interruptions as described above in the odontocete overview.

Below we compile and summarize the information that supports our preliminary determinations that the Navy's activities would not adversely affect any of the dolphins and small whales through effects on annual rates of recruitment or survival.

Killer Whales (Eastern North Pacific Offshore; Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient)

No killer whale stocks in the TMAA are listed as DPSs under the ESA, and no BIAs for killer whales have been identified in the GOA Study Area. The Eastern North Pacific Offshore stock is reported as ''stable,'' and the population trend of the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is unknown.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 27 percent for the Eastern North Pacific Offshore stock and 24 percent for the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock. This information indicates that only a portion of each stock is likely impacted, with those individuals disturbed on likely one, but not more than a few non-sequential days within the 21 days per year. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB (*i.e.,* of a lower, to occasionally moderate, level and less likely to evoke a severe response). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with killer whale communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, these killer whale stocks are not listed under the ESA. The Eastern North Pacific Offshore stock is reported as ''stable,'' and the population trend of the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is unknown. Only a portion of these killer whale stocks is anticipated to be impacted, and any individual is likely to be disturbed at a low-moderate level, with the taken individuals likely exposed on one day but not more than a few non-sequential days within a year. This low magnitude and severity of harassment effects is unlikely to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of either of the stocks. No mortality or Level A harassment is anticipated or proposed for authorization for either of the stocks. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on these killer whale stocks.

Pacific White-Sided Dolphins (North Pacific Stock)

Pacific white-sided dolphins are not listed under the ESA and the current population trend of the North Pacific stock is unknown. No BIAs for this stock have been identified in the GOA Study Area.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 6 percent. Given the number of takes, only a small portion of the stock is likely impacted, and individuals are likely disturbed between one and a few days, most likely non-sequential, within a year. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB (*i.e.,* of a lower, to occasionally moderate, level and less likely to evoke a severe response). However, while interrupted feeding bouts are a known response and concern for odontocetes, we also know that there are often viable alternative habitat options nearby. Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with dolphin communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

Altogether, though the status of this stock is unknown, this stock is not listed under the ESA. Any individual is likely to be disturbed at a low-moderate level, and those individuals likely disturbed on one to a few non-sequential days within a year. This low magnitude and severity of harassment effects is not expected to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the North Pacific stock of Pacific white-sided dolphins.

Dall's Porpoise (Alaska Stock)

This section builds on the broader odontocete discussion above and brings together the discussion of the different types and amounts of take that this porpoise stock would likely incur, the applicable mitigation, and the status of the stock to support the negligible impact determination.

In Table 45 below for Dall's porpoise, we indicate the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 45—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR DALL'S PORPOISE IN THE TMAA AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take [1]			Total takes	Abundance (NMFS SARs) [2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
Dall's porpoise	Alaska	348	8,939	64	9,351	83,400	11.2

[1] Estimated impacts are based on the maximum number of activities in a given year under the Specified Activity. Not all takes represent separate individuals, especially for disturbance.
[2] Presented in the 2021 draft SARs or most recent SAR.

Dall's porpoise is not listed under the ESA and the current population trend for the Alaska stock is unknown. No BIAs for Dall's porpoise have been identified in the GOA Study Area.

While harbor porpoises have been observed to be especially sensitive to human activity, the same types of responses have not been observed in Dall's porpoises. Dall's porpoises are typically notably longer than, and weigh more than twice as much as, harbor porpoises, making them generally less likely to be preyed upon and likely differentiating their behavioral repertoire somewhat from harbor porpoises. Further, they are typically seen in large groups and feeding aggregations, or exhibiting bow-riding behaviors, which is very different from the group dynamics observed in the more typically solitary, cryptic harbor porpoises, which are not often seen bow-riding. For these reasons, Dall's porpoises are not treated as an especially sensitive species (versus harbor porpoises which have a lower behavioral harassment threshold and more distant cutoff) but, rather, are analyzed similarly to other odontocetes (with takes from the sonar bin in the TMAA resulting from the same received levels reported in the *Odontocete* section above). Therefore, the majority of Level B harassment by behavioral disturbance is expected to be in the form of milder responses compared to higher level exposures. As mentioned earlier in this section, we anticipate more severe effects from takes when animals are exposed to higher received levels.

We note that Dall's porpoise, as a HF-sensitive species, has a lower PTS threshold than other groups and therefore is generally more likely to experience TTS and PTS, and potentially occasionally to a greater degree, and NMFS accordingly has evaluated and authorized higher numbers. Also, however, regarding PTS from sonar exposure, porpoises are still likely to avoid sound levels that would cause higher levels of TTS (greater than 20 dB) or PTS. Therefore, even though the number of TTS takes are higher than for other odontocetes, any PTS is expected to be at a lower to occasionally moderate level and for all of the reasons described above, TTS and PTS takes are not expected to impact reproduction or survival of any individual.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance), the number of estimated total instances of take compared to the abundance is 11 percent. This indicates that only a small portion of this stock is likely to be impacted, and a subset of those individuals would likely be taken on no more than a few non-sequential days within a year. Regarding the severity of those individual takes by Level B harassment by behavioral disturbance, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 172 dB (*i.e.,* of a lower, to occasionally moderate, level and less likely to evoke a severe response). Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival.

For the same reasons explained above for TTS (low to occasionally moderate level and the likely frequency band), while a small permanent loss of hearing sensitivity may include some degree of energetic costs for compensating or may mean some small loss of opportunities or detection capabilities, the estimated annual takes by Level A harassment by PTS for this stock (64 takes) would be unlikely to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival of any individuals.

Altogether, the status of the Alaska stock of Dall's porpoise is unknown, however Dall's porpoise are not listed as endangered or threatened under the ESA. Only a small portion of this stock is likely to be impacted, any individual is likely to be disturbed at a low-moderate level, and a subset of taken individuals would likely be taken on a few non-sequential days within a year. This low magnitude and severity of Level B harassment effects is not expected to result in impacts on individual reproduction or survival, much less annual rates of recruitment or survival. Some individuals (64 annually) could be taken by PTS of likely low to occasionally moderate severity. A small permanent loss of hearing sensitivity (PTS) may include some degree of energetic costs for compensating or may mean some small loss of opportunities or detection capabilities, but at the expected scale the estimated takes by Level A harassment by PTS for this stock would be unlikely, alone or in combination with the Level B harassment take by behavioral disturbance and TTS, to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury and no Level A harassment from non-auditory tissue damage is anticipated or proposed for authorization. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Navy's activities combined, that the proposed authorized take would have a negligible impact on the Alaska stock of Dall's porpoise.

Pinnipeds

This section builds on the broader discussion above and brings together the discussion of the different types and amounts of take that different species and stocks would likely incur, the applicable mitigation, and the status of the species and stocks to support the negligible impact determinations for each species or stock. We have described (earlier in this section) the unlikelihood of any masking having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. We have also described above in the Potential Effects of Specified Activities on Marine Mammals and their Habitat section the unlikelihood of any habitat impacts having effects that would impact the reproduction or survival of any of the individual marine mammals affected by the Navy's activities. For pinnipeds, there is no mortality or serious injury and no Level A harassment from non-auditory tissue damage from sonar or explosives anticipated or proposed to be authorized for any species.

Regarding behavioral disturbance, 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 non-pulse sounds in water (Costa *et al.,* 2003; Jacobs and Terhune, 2002; 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 (Blackwell *et al.,* 2004; Harris *et al.,* 2001; 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. Effects on pinnipeds that are taken by Level B harassment in the TMAA, on the basis of reports in the literature as well as Navy monitoring from past activities, would likely be limited to reactions such as increased swimming speeds, increased surfacing time, or decreased foraging (if such activity were occurring). Most likely, individuals would simply move away from the sound source and be temporarily displaced from those areas, or not respond at all, which would have no effect on reproduction or survival. 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. Given their documented tolerance of anthropogenic sound (Richardson *et al.,* 1995 and Southall *et al.,* 2007), repeated exposures of individuals of any of these species to levels of sound that may cause Level B harassment are unlikely to result in hearing impairment or to significantly disrupt foraging behavior. Thus, even repeated Level B harassment of some small subset of individuals of an overall stock is unlikely to result in any significant realized decrease in fitness to those individuals that would result in any adverse impact on rates of recruitment or survival for the stock as a whole.

While no take of Steller sea lion is anticipated or proposed to be authorized, we note that the GOA Study Area boundary was intentionally designed to avoid ESA-designated Steller sea lion critical habitat.

All the pinniped species discussed in this section would benefit from the procedural mitigation measures described earlier in the Proposed Mitigation Measures section.

In Table 46 below for pinnipeds, we indicate the total annual numbers of take by Level A harassment and Level B harassment, and a number indicating the instances of total take as a percentage of abundance.

TABLE 46—ANNUAL ESTIMATED TAKES BY LEVEL B HARASSMENT AND LEVEL A HARASSMENT FOR PINNIPEDS IN THE TMAA AND NUMBER INDICATING THE INSTANCES OF TOTAL TAKE AS A PERCENTAGE OF SPECIES/STOCK ABUNDANCE

Species	Stock	Instances of indicated types of incidental take [1]			Total Takes	Abundance (NMFS SARs) [2]	Instances of total take as percentage of abundance
		Level B harassment		Level A harassment			
		Behavioral disturbance	TTS (may also include disturbance)	PTS			
Northern fur seal	Eastern Pacific	2,972	31	0	3,003	626,618	<1
Northern fur seal	California	60	1	0	61	14,050	<1
Northern elephant seal	California	904	1,643	8	2,555	187,386	1.3

[1] Estimated impacts are based on the maximum number of activities in a given year under the specified activity. Not all takes represent separate individuals, especially for disturbance.
[2] Presented in the 2021 draft SARs or most recent SAR.

The majority of takes by harassment of pinnipeds in the TMAA are caused by sources from the MFAS bin (which includes hull-mounted sonar) because they are high level sources at a frequency (1–10 kHz) which overlaps the most sensitive portion of the pinniped hearing range, and of the sources expected to result in take, they are used in a large portion of exercises (see Table 1 and Table 3). Most of the takes (>99 percent) from the MF1 bin in the TMAA would result from received levels between 166 and 178 dB SPL. For the remaining active sonar bin types, the percentages are as follows: MF4 = 97 percent between 148 and 172 dB SPL and MF5 = 99 percent between 130 and

160 dB SPL. Given the levels they are exposed to and pinniped sensitivity, most responses would be of a lower severity, with only occasional responses likely to be considered moderate, but still of generally short duration.

As mentioned earlier in this section, we anticipate more severe effects from takes when animals are exposed to higher received levels. Occasional milder takes by Level B harassment by behavioral disturbance are unlikely to cause long-term consequences for individual animals or populations, especially when they are not expected to be repeated over sequential multiple days. For all pinnipeds except Northern elephant seals, no take is expected to occur from explosives. For Northern elephant seals, harassment takes from explosives (behavioral disturbance, TTS, and PTS) comprise a very small fraction of those caused by exposure to active sonar.

Because the majority of harassment takes of pinnipeds result from narrowband sources in the range of 1–10 kHz, the vast majority of threshold shift caused by Navy sonar sources would typically occur in the range of 2–20 kHz. This frequency range falls within the range of pinniped hearing, however, pinniped vocalizations typically span a somewhat lower range than this (<0.2 to 10 kHz) and threshold shift from active sonar would often be in a narrower band (reflecting the narrower band source that caused it), which means that TTS incurred by pinnipeds would typically only interfere with communication within a portion of a pinniped's range (if it occurred during a time when communication with conspecifics was occurring). As discussed earlier, it would only be expected to be of a short duration and relatively small degree. Many of the other critical sounds that serve as cues for navigation and prey (*e.g.,* waves, fish, invertebrates) occur below a few kHz, which means that detection of these signals would not be inhibited by most threshold shifts either. The very low number of takes by threshold shifts that might be incurred by individuals exposed to explosives would likely be lower frequency (5 kHz or less) and spanning a wider frequency range, which could slightly lower an individual's sensitivity to navigational or prey cues, or a small portion of communication calls, for several minutes to hours (if temporary) or permanently.

Neither of these species are ESA-listed and the SAR indicates that the status of the Eastern Pacific stock of Northern fur seal is stable, the California stock of Northern fur seal is increasing, and the California stock of Northern elephant seal is increasing. BIAs have not been identified for pinnipeds.

Regarding the magnitude of takes by Level B harassment (TTS and behavioral disturbance) for the Eastern Pacific and California stocks of Northern fur seals, the estimated instances of takes as compared to the stock abundance is <1 percent for each stock. For the California stock of Northern elephant seal, the number of estimated total instances of take compared to the abundance is 1 percent. This information indicates that only a very small portion of individuals in these stocks are likely impacted, particularly given the large ranges of the stocks. Impacted individuals would be disturbed on likely one, but not more than a few non-sequential days within a year.

Regarding the severity of those individual takes by Level B harassment by behavioral disturbance for all pinniped stocks, we have explained that the duration of any exposure is expected to be between minutes and hours (*i.e.,* relatively short) and the received sound levels largely below 178 dB, which is considered a relatively low to occasionally moderate level for pinnipeds.

Regarding the severity of TTS takes, they are expected to be low-level, of short duration, and mostly not in a frequency band that would be expected to interfere with pinniped communication or other important low-frequency cues. Therefore, the associated lost opportunities and capabilities are not at a level that would impact reproduction or survival. For these same reasons (low level and frequency band), while a small permanent loss of hearing sensitivity may include some degree of energetic costs for compensating or may mean some small loss of opportunities or detection capabilities, the 8 estimated Level A harassment takes by PTS for the California stock of Northern elephant seal would be unlikely to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival of any individuals.

Altogether, none of these species are listed under the ESA, and the SARs indicate that the status of the Eastern Pacific stock of Northern fur seal is stable, the California stock of Northern fur seal is increasing, and the California stock of Northern elephant seal is increasing. No mortality or serious injury and no Level A harassment from non-auditory tissue damage for pinnipeds is anticipated or proposed for authorization. Level A harassment by PTS is only anticipated for the California stock of Northern elephant seal (8 takes by Level A harassment). For all three pinniped stocks, only a small portion of the stocks are anticipated to be impacted and any individual is likely to be disturbed at a low-moderate level. This low magnitude and severity of harassment effects is not expected to result in impacts on individual reproduction or survival, let alone have impacts on annual rates of recruitment or survival of these stocks. For these reasons, in consideration of all of the effects of the Navy's activities combined, we have preliminarily determined that the proposed authorized take would have a negligible impact on all three stocks of pinnipeds.

Preliminary Determination

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from the specified activities will have a negligible impact on all affected marine mammal species or stocks.

Subsistence Harvest of Marine Mammals

In order to issue an incidental take authorization, NMFS must find that the specified activity will not have an ''unmitigable adverse impact'' on the subsistence uses of the affected marine mammal species or stocks by Alaska Natives. NMFS has defined ''unmitigable adverse impact'' in 50 CFR 216.103 as an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

When applicable, NMFS must prescribe means of effecting the least practicable adverse impact on the availability of the species or stocks for subsistence uses. As discussed in the Proposed Mitigation Measures section, evaluation of potential mitigation measures includes consideration of two primary factors: (1) The manner in which, and the degree to which, implementation of the potential measure(s) is expected to reduce adverse impacts on the availability of species or stocks for subsistence uses, and (2) the practicability of the measure(s) for applicant implementation.

The Navy has met with and will continue to engage in meaningful consultation and communication with several federally recognized Alaska Native tribes that have traditional marine mammal harvest areas in the GOA (though, as noted below, these areas do not overlap directly with the GOA Study Area). Further, the Navy will continue to keep the Tribes informed of the timeframes of future joint training exercises.

To our knowledge, subsistence hunting of marine mammals does not occur in the GOA Study Area where training activities would occur. The GOA Study Area is located over 12 nmi from shore with the nearest inhabited land being the Kenai Peninsula (24 nmi from the GOA Study Area). Information provided by Tribes in previous conversations with the Navy, and according to Alaska Department of Fish and Game (1995), indicates that harvest of pinnipeds occurs nearshore, and the Tribes do not use the GOA Study Area for subsistence hunting of marine mammals. The TMAA portion of the GOA Study Area is the closest to the area of nearshore subsistence harvest conducted by the Sun'aq Tribe of Kodiak, the Native Village of Eyak, and the Yakutat Tlingit Tribe (Alaska Department of Fish and Game, 1995). The WMA is offshore of subsistence harvest areas that occur in Unalaska, Akutan, False Pass, Sand Point, and King Cove (Alaska Department of Fish and Game, 1997). The Tribes listed here harvest harbor seals and sea lions (Alaska Department of Fish and Game, 1995, 1997).

In addition to the distance between subsistence hunting areas and the GOA Study Area, which would ensure that the Navy's activities do not displace subsistence users or place physical barriers between the marine mammals and the subsistence hunters, there is no reason to believe that any behavioral disturbance or limited TTS or PTS of pinnipeds that occurs offshore in the GOA Study Area would affect their subsequent behavior in a manner that would interfere with subsistence uses should those pinnipeds later interact with hunters, particularly given that neither harbor seals, Steller sea lions, or California sea lions are expected to be taken by the Navy's training activities. The specified activity would be a continuation of the types of training activities that have been ongoing for more than a decade, and as discussed in the 2011 GOA FEIS/OEIS and 2016 GOA FSEIS/OEIS, no impacts on traditional subsistence practices or resources are predicted to result from the specified activity.

Based on the information above, NMFS has preliminarily determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of the species or stocks for taking for subsistence purposes. However, we have limited information on marine mammal subsistence use in the GOA Study Area and seek additional information pertinent to making the final determination.

Classification

Endangered Species Act

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 GOA Study Area: North Pacific right whale, humpback whale (Mexico, Western North Pacific, and Central America DPSs), blue whale, fin whale, sei whale, gray whale (Western North Pacific stock), sperm whale, and Steller sea lion (Western DPS). The humpback whale has critical habitat recently designated under the ESA in the TMAA portion of the GOA Study Area (86 FR 21082; April 21, 2021). As discussed previously, the GOA Study Area boundaries were intentionally designed to avoid ESA-designated critical habitat for Steller sea lions.

The Navy will consult with NMFS pursuant to section 7 of the ESA for GOA Study Area activities. NMFS will also consult internally on the issuance of the regulations and an LOA under section 101(a)(5)(A) of the MMPA.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must evaluate our proposed actions and alternatives with respect to potential impacts on the human environment. Accordingly, NMFS plans to adopt the GOA SEIS/OEIS for the GOA Study Area provided our independent evaluation of the document finds that it includes adequate information analyzing the effects on the human environment of issuing regulations and an LOA under the MMPA. NMFS is a cooperating agency on the 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS and has worked extensively with the Navy in developing the documents. The 2020 GOA DSEIS/OEIS and 2022 Supplement to the 2020 GOA DSEIS/OEIS were made available for public comment in February 2020 and March 2022, respectively, at *https://www.goaeis.com/,* which also provides additional information about the NEPA process. We will review all comments prior to concluding our NEPA process and making a final decision on the MMPA rulemaking and request for a LOA.

Regulatory Flexibility Act

The Office of Management and Budget has determined that this proposed rule is not significant for purposes of Executive Order 12866.

Pursuant to the Regulatory Flexibility Act (RFA), the Chief Counsel for Regulation of the Department of Commerce has certified to the Chief Counsel for Advocacy of the Small Business Administration that this proposed rule, if adopted, would not have a significant economic impact on a substantial number of small entities. The RFA requires Federal agencies to prepare an analysis of a rule's impact on small entities whenever the agency is required to publish a notice of proposed rulemaking. However, a Federal agency may certify, pursuant to 5 U.S.C. 605(b), that the action will not have a significant economic impact on a substantial number of small entities. The Navy is the sole entity that 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 that 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: July 28, 2022.

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.*, unless otherwise noted.

■ 2. Revise subpart P to read as follows:

Subpart P—Taking and Importing Marine Mammals; U.S. Navy Training Activities in the Gulf of Alaska Study Area

Sec.

§ 218.150 Specified activity and geographical region.

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

(b) The GOA Study Area is entirely at sea and is comprised of three areas: a Temporary Maritime Activities Area (TMAA) a warning area, and the Western Maneuver Area (WMA) located south and west of the TMAA. The TMAA and WMA are temporary areas established within the GOA for ships, submarines, and aircraft to conduct training activities. The TMAA is a polygon roughly resembling a rectangle oriented from northwest to southeast, approximately 300 nautical miles (nmi; 556 km) in length by 150 nmi (278 km) in width, located south of Montague Island and east of Kodiak Island. The warning area overlaps and extends slightly beyond the northern corner of the TMAA. The WMA provides an additional 185,806 nmi^2 of surface, sub-surface, and airspace training area to support activities occurring within the TMAA. The boundary of the WMA follows the bottom of the slope at the 4,000 m contour line.

(c) The taking of marine mammals by the Navy is only authorized if it occurs incidental to the Navy conducting training activities, including:

(1) Anti-submarine warfare; and

(2) Surface warfare.

§ 218.151 Effective dates.

Regulations in this subpart are effective from December 15, 2022 through December 14, 2029.

§ 218.152 Permissible methods of taking.

(a) Under a Letter of Authorization (LOA) issued pursuant to § 216.106 of this chapter and § 218.156, the Holder of the LOA (hereinafter ''Navy'') may incidentally, but not intentionally, take marine mammals within the TMAA only, as described in § 218.150(b), by Level A harassment and Level B harassment associated with the use of active sonar and other acoustic sources and explosives, provided the activity is in compliance with all terms, conditions, and requirements of this subpart and the applicable LOA.

(b) The incidental take of marine mammals by the activities listed in § 218.150(c) is limited to the following species:

TABLE 1 TO § 218.152(b)

Species	Stock
Blue whale	Central North Pacific.
Blue whale	Eastern North Pacific.
Fin whale	Northeast Pacific.
Humpback whale	Western North Pacific.
Humpback whale	Central North Pacific.
Humpback whale	California/Oregon/Washington.
Minke whale	Alaska.
North Pacific right whale	Eastern North Pacific.
Sei whale	Eastern North Pacific.
Gray whale	Eastern North Pacific.
Killer whale	Eastern North Pacific Offshore.
Killer whale	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient.
Pacific white-sided dolphin	North Pacific.
Dall's porpoise	Alaska.
Sperm whale	North Pacific.
Baird's beaked whale	Alaska.
Cuvier's beaked whale	Alaska.
Stejneger's beaked whale	Alaska.
Northern fur seal	Eastern Pacific.
Northern fur seal	California.
Northern elephant seal	California.

§ 218.153 Prohibitions.

(a) Except for incidental takings contemplated in § 218.152(a) and authorized by an LOA issued under §§ 216.106 of this chapter and 218.156, it shall be unlawful for any person to do any of the following in connection with the activities listed in § 218.150(c):

(1) Violate, or fail to comply with, the terms, conditions, and requirements of this subpart or an LOA issued under §§ 216.106 of this chapter and 218.156;

(2) Take any marine mammal not specified in § 218.152(b);

(3) Take any marine mammal specified in § 218.152(b) in any manner other than as specified in the LOA; or

(4) Take a marine mammal specified in § 218.152(b) if NMFS determines such taking results in more than a negligible impact on the species or stocks of such marine mammal.

(b) [Reserved]

§ 218.154 Mitigation requirements.

(a) When conducting the activities identified in § 218.150(c), the mitigation measures contained in any LOA issued under §§ 216.106 of this chapter and 218.156 must be implemented. These mitigation measures include, but are not limited to:

(1) *Procedural mitigation.* Procedural mitigation is mitigation that the Navy must implement whenever and wherever an applicable training activity takes place within the GOA Study Area for acoustic stressors (*i.e.,* active sonar, weapons firing noise), explosive stressors (*i.e.,* large-caliber projectiles, bombs), and physical disturbance and strike stressors (*i.e.,* vessel movement, towed in-water devices, small-, medium-, and large-caliber non-explosive practice munitions, non-explosive bombs).

(i) *Environmental awareness and education.* Appropriate Navy personnel (including civilian personnel) involved in mitigation and training activity reporting under the specified activities will complete the environmental compliance training modules identified in their career path training plan, as specified in the LOA.

(ii) *Active sonar.* Active sonar includes mid-frequency active sonar, and high-frequency active sonar. For vessel-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned surface vessels (*e.g.,* sonar sources towed from manned surface platforms). For aircraft-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned aircraft that do not operate at high altitudes (*e.g.,* rotary-wing aircraft). Mitigation does not apply to active sonar sources deployed from unmanned aircraft or aircraft operating at high altitudes (*e.g.,* maritime patrol aircraft).

(A) *Number of Lookouts and observation platform for hull-mounted sources.* For hull-mounted sources, the Navy must have one Lookout for platforms with space or manning restrictions while underway (at the forward part of a small boat or ship) and platforms using active sonar while moored or at anchor; and two Lookouts for platforms without space or manning restrictions while underway (at the forward part of the ship).

(B) *Number of Lookouts and observation platform for sources not hull-mounted.* For sources that are not hull-mounted, the Navy must have one Lookout on the ship or aircraft conducting the activity.

(C) *Prior to activity.* Prior to the initial start of the activity (*e.g.,* when maneuvering on station), Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of active sonar transmission until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(ii)(F) of this section are met for marine mammals.

(D) *During the activity for hull-mounted mid-frequency active sonar.* During the activity, for hull-mounted mid-frequency active sonar, Navy personnel must observe the following mitigation zones for marine mammals.

(*1*) *Powerdowns for marine mammals.* Navy personnel must power down active sonar transmission by 6 dB if a marine mammal is observed within 1,000 yd (914.4 m) of the sonar source; Navy personnel must power down active sonar transmission an additional 4 dB (10 dB total) if a marine mammal is observed within 500 yd (457.2 m) of the sonar source.

(*2*) *Shutdowns for marine mammals.* Navy personnel must cease transmission if a marine mammal is observed within 200 yd (182.9 m) of the sonar source.

(E) *During the activity, for mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar.* During the activity, for mid-frequency active sonar sources that are not hull-mounted and high-frequency active sonar, Navy personnel must observe the mitigation zone for marine mammals. Navy personnel must cease transmission if a marine mammal is observed within 200 yd (182.9 m) of the sonar source.

(F) *Commencement/recommencement conditions after a marine mammal sighting before or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing or powering up active sonar transmission) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the sonar source;

(*3*) *Clear from additional sightings.* The mitigation zone has been clear from any additional sightings for 10 minutes (min) for aircraft-deployed sonar sources or 30 minutes for vessel-deployed sonar sources;

(*4*) *Sonar source transit.* For mobile activities, the active sonar source has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or

(*5*) *Bow-riding dolphins.* For activities using hull-mounted sonar, the Lookout concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave, and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone).

(iii) *Weapons firing noise.* Weapons firing noise associated with large-caliber gunnery activities.

(A) *Number of Lookouts and observation platform.* One Lookout must be positioned on the ship conducting the firing. Depending on the activity, the Lookout could be the same as the one provided for under ''Explosive large-caliber projectiles'' or under ''Small-, medium-, and large-caliber non-explosive practice munitions'' in paragraphs (a)(1)(iv)(A) and (a)(1)(viii)(A) of this section.

(B) *Mitigation zone.* Thirty degrees on either side of the firing line out to 70 yd (64 m) from the muzzle of the weapon being fired.

(C) *Prior to activity.* Prior to the initial start of the activity, Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of weapons firing until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(iii)(E) of this section are met for marine mammals.

(D) *During activity.* During the activity, Navy personnel must observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel must cease weapons firing.

(E) *Commencement/recommencement conditions after a marine mammal sighting before or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing weapons firing) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the firing ship;

(*3*) *Clear from additional sightings.* The mitigation zone has been clear from any additional sightings for 30 min; or

(*4*) *Firing ship transit.* For mobile activities, the firing ship has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

(iv) *Explosive large-caliber projectiles.* Gunnery activities using explosive large-caliber projectiles. Mitigation applies to activities using a surface target.

(A) *Number of Lookouts and observation platform.* One Lookout must be on the vessel or aircraft conducting the activity. Depending on the activity, the Lookout could be the same as the one described in ''Weapons firing noise'' in paragraph (a)(1)(iii)(A) of this section. If additional platforms are participating in the activity, Navy personnel positioned in those assets (*e.g.,* safety observers, evaluators) must support observing the mitigation zone for marine mammals while performing their regular duties.

(B) *Mitigation zones.* 1,000 yd (914.4 m) around the intended impact location.

(C) *Prior to activity.* Prior to the initial start of the activity (*e.g.,* when maneuvering on station), Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of firing until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(iv)(E) of this section are met for marine mammals.

(D) *During activity.* During the activity, Navy personnel must observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel must cease firing.

(E) *Commencement/recommencement conditions after a marine mammal sighting before or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location;

(*3*) *Clear of additional sightings.* The mitigation zone has been clear from any additional sightings for 30 minutes; or,

(*4*) *Impact location transit.* For activities using mobile targets, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

(F) *After activity.* After completion of the activity (*e.g.,* prior to maneuvering off station), Navy personnel must, when practical (*e.g.,* when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe for marine mammals in the vicinity of where detonations occurred; if any injured or dead marine mammals are observed, Navy personnel must follow established incident reporting procedures. If additional platforms are supporting this activity (*e.g.,* providing range clearance), Navy personnel positioned on these Navy assets must assist in the visual observation of the area where detonations occurred.

(v) *Explosive bombs.*

(A) *Number of Lookouts and observation platform.* One Lookout must be positioned in an aircraft conducting the activity. If additional platforms are participating in the activity, Navy personnel positioned in those assets (*e.g.,* safety observers, evaluators) must support observing the mitigation zone for marine mammals while performing their regular duties.

(B) *Mitigation zone.* 2,500 yd (2,286 m) around the intended target.

(C) *Prior to activity.* Prior to the initial start of the activity (*e.g.,* when arriving on station), Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of bomb deployment until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(v)(E) of this section are met for marine mammals.

(D) *During activity.* During the activity (*e.g.,* during target approach), Navy personnel must observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel must cease bomb deployment.

(E) *Commencement/recommencement conditions after a marine mammal sighting before or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended target;

(*3*) *Clear from additional sightings.* The mitigation zone has been clear from any additional sightings for 10 min; or

(*4*) *Intended target transit.* For activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

(F) *After activity.* After completion of the activity (*e.g.,* prior to maneuvering off station), Navy personnel must, when practical (*e.g.,* when platforms are not constrained by fuel restrictions or mission-essential follow-on commitments), observe for marine mammals in the vicinity of where detonations occurred; if any injured or dead marine mammals are observed, Navy personnel must follow established incident reporting procedures. If additional platforms are supporting this activity (*e.g.,* providing range clearance), Navy personnel positioned on these Navy assets must assist in the visual observation of the area where detonations occurred.

(vi) *Vessel movement.* The mitigation will not be applied if: the vessel's safety is threatened; the vessel is restricted in its ability to maneuver (*e.g.,* during launching and recovery of aircraft or landing craft, during towing activities, when mooring); the vessel is submerged or operated autonomously; or when impractical based on mission requirements (*e.g.,* during Vessel Visit, Board, Search, and Seizure activities as military personnel from ships or aircraft board suspect vessels).

(A) *Number of Lookouts and observation platform.* One or more Lookouts must be on the underway vessel. If additional watch personnel are positioned on the underway vessel, those personnel (*e.g.,* persons assisting with navigation or safety) must support observing for marine mammals while performing their regular duties.

(B) *Mitigation zone.*

(*1*) *Whales.* 500 yd (457.2 m) around the vessel for whales.

(*2*) *Marine mammals other than whales.* 200 yd (182.9 m) around the vessel for all marine mammals other than whales (except those intentionally swimming alongside or closing in to swim alongside vessels, such as bow-riding or wake-riding dolphins).

(C) *When underway.* Navy personnel will observe the direct path of the vessel and waters surrounding the vessel for marine mammals. If a marine mammal is observed in the direct path of the vessel, Navy personnel will maneuver the vessel as necessary to maintain the appropriate mitigation zone distance. If a marine mammal is observed within waters surrounding the vessel, Navy personnel will maintain situational awareness of that animal's position. Based on the animal's course and speed relative to the vessel's path, Navy personnel will maneuver the vessel as necessary to ensure that the appropriate mitigation zone distance from the animal continues to be maintained.

(D) *Incident reporting procedures.* If a marine mammal vessel strike occurs, Navy personnel must follow the established incident reporting procedures.

(vii) *Towed in-water devices.* Mitigation applies to devices that are towed from a manned surface platform or manned aircraft, or when a manned support craft is already participating in an activity involving in-water devices being towed by unmanned platforms. The mitigation will not be applied if the safety of the towing platform or in-water device is threatened.

(A) *Number of Lookouts and observation platform.* One Lookout must be positioned on a manned towing platform or support craft.

(B) *Mitigation zone.* 250 yd (228.6 m) around the towed in-water device for marine mammals (except those intentionally swimming alongside or choosing to swim alongside towing vessels, such as bow-riding or wake-riding dolphins).

(C) *During activity.* During the activity (*i.e.,* when towing an in-water device), Navy personnel must observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel must maneuver to maintain distance.

(viii) *Small-, medium-, and large-caliber non-explosive practice munitions.* Gunnery activities using small-, medium-, and large-caliber non-explosive practice munitions. Mitigation applies to activities using a surface target.

(A) *Number of Lookouts and observation platform.* One Lookout must be positioned on the platform conducting the activity. Depending on the activity, the Lookout could be the same as the one described for ''Weapons firing noise'' in paragraph (a)(1)(iii)(A) of this section.

(B) *Mitigation zone.* 200 yd (182.9 m) around the intended impact location.

(C) *Prior to activity.* Prior to the initial start of the activity (*e.g.,* when maneuvering on station), Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of firing until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(viii)(E) of this section are met for marine mammals.

(D) *During activity.* During the activity, Navy personnel must observe the mitigation zone for marine mammals; if a marine mammal is observed, Navy personnel must cease firing.

(E) *Commencement/recommencement conditions after a marine mammal sighting before or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing firing) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location;

(*3*) *Clear of additional sightings.* The mitigation zone has been clear from any additional sightings for 10 minutes for aircraft-based firing or 30 minutes for vessel-based firing; or

(*4*) *Impact location transit.* For activities using a mobile target, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

(ix) *Non-explosive bombs.* Non-explosive bombs.

(A) *Number of Lookouts and observation platform.* One Lookout must be positioned in an aircraft.

(B) *Mitigation zone.* 1,000 yd (914.4 m) around the intended target.

(C) *Prior to activity.* Prior to the initial start of the activity (*e.g.,* when arriving on station), Navy personnel must observe the mitigation zone for floating vegetation and marine mammals; if floating vegetation or a marine mammal is observed, Navy personnel must relocate or delay the start of bomb deployment until the mitigation zone is clear of floating vegetation or until the conditions in paragraph (a)(1)(ix)(E) of this section are met for marine mammals.

(D) *During activity.* During the activity (*e.g.,* during approach of the target), Navy personnel must observe the mitigation zone for marine mammals and, if a marine mammal is observed, Navy personnel must cease bomb deployment.

(E) *Commencement/recommencement conditions after a marine mammal sighting prior to or during the activity.* Navy personnel must allow a sighted marine mammal to leave the mitigation zone prior to the initial start of the activity (by delaying the start) or during the activity (by not recommencing bomb deployment) until one of the following conditions has been met:

(*1*) *Observed exiting.* The animal is observed exiting the mitigation zone;

(*2*) *Thought to have exited.* The animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended target;

(*3*) *Clear from additional sightings.* The mitigation zone has been clear from any additional sightings for 10 min; or

(*4*) *Intended target transit.* For activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

(2) *Mitigation areas.* In addition to procedural mitigation, Navy personnel must implement mitigation measures within mitigation areas to avoid or reduce potential impacts on marine mammals.

(i) *North Pacific Right Whale Mitigation Area.* Figure 1 shows the location of the mitigation area.

(A) *Surface ship hull-mounted MF1 mid-frequency active sonar.* From June 1–September 30 within the North Pacific Right Whale Mitigation Area, Navy personnel must not use surface ship hull-mounted MF1 mid-frequency active sonar during training.

(B) *National security exception.* Should national security require that the Navy cannot comply with the restrictions in paragraph (a)(2)(i)(A) of this section, Navy personnel must obtain permission from the designated Command, U.S. Third Fleet Command Authority, prior to commencement of the activity. Navy personnel must provide NMFS with advance notification and include information about the event in its annual activity reports to NMFS.

(ii) *Continental Shelf and Slope Mitigation Area.* Figure 1 shows the location of the mitigation area.

(A) *Explosives.* Navy personnel must not detonate explosives below 10,000 ft. altitude (including at the water surface) in the Continental Shelf and Slope Mitigation Area during training.

(B) *National security exception.* Should national security require that the Navy cannot comply with the restrictions in paragraph (a)(2)(ii)(A) of this section, Navy personnel must obtain permission from the designated Command, U.S. Third Fleet Command Authority, prior to commencement of the activity. Navy personnel must provide NMFS with advance notification and include information about the event in its annual activity reports to NMFS.

(iii) *Pre-event Awareness Notifications in the Temporary Maritime Activities Area.* The Navy must issue pre-event awareness messages to alert vessels and aircraft participating in training activities within the TMAA to the possible presence of concentrations of large whales on the continental shelf and slope. Occurrences of large whales may be higher over the continental shelf and slope relative to other areas of the TMAA. Large whale species in the TMAA include, but are not limited to, fin whale, blue whale, humpback whale, gray whale, North Pacific right whale, sei whale, and sperm whale. To maintain safety of navigation and to avoid interactions with marine mammals, the Navy must instruct personnel to remain vigilant to the presence of large whales that may be vulnerable to vessel strikes or potential impacts from training activities. Additionally, Navy personnel must use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training activities and to aid in the implementation of procedural mitigation.

BILLING CODE 3510–22–P

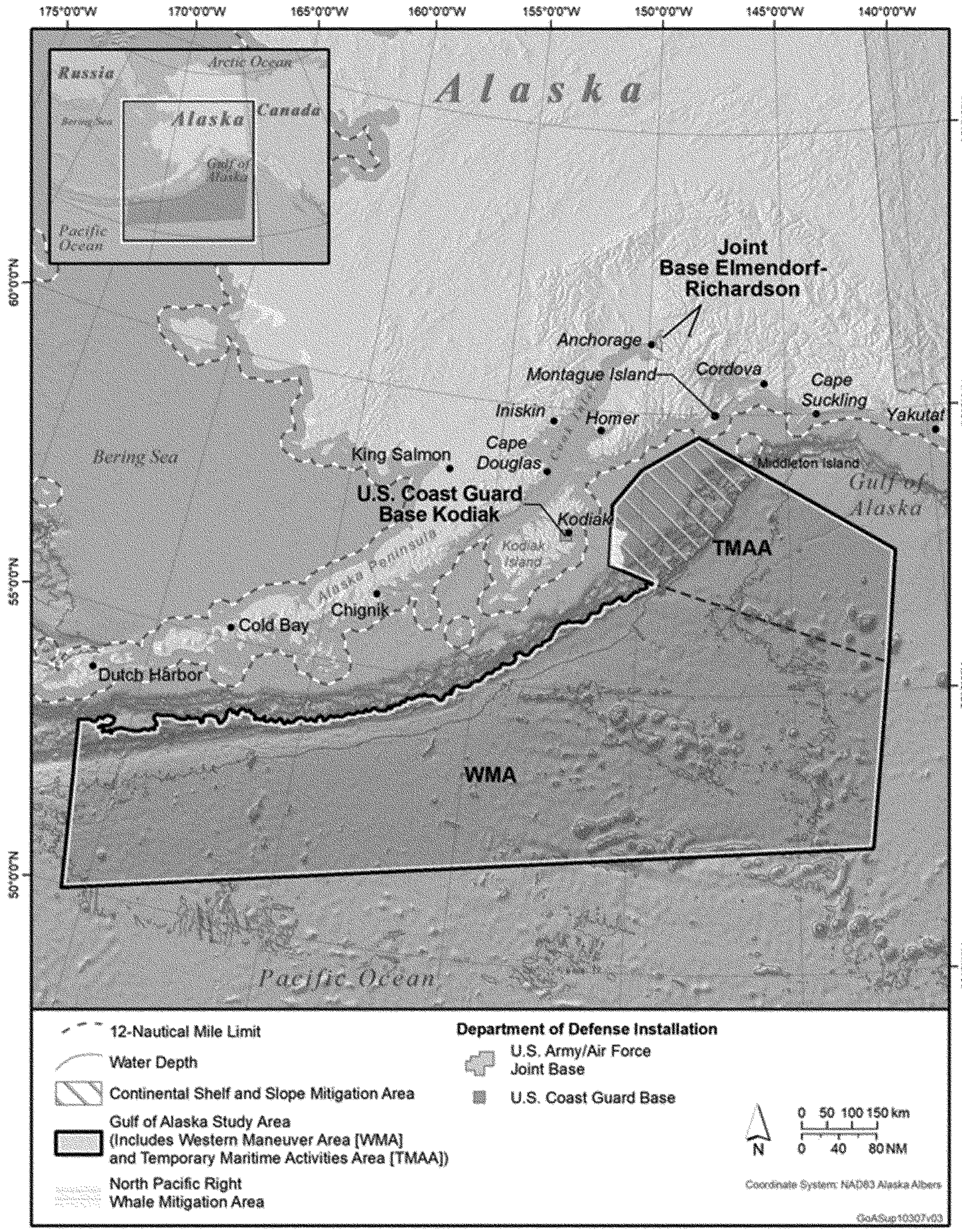

Figure 1-- Geographic Mitigation Areas for Marine Mammals in the GOA Study Area

BILLING CODE 3510–22–C

(b) [Reserved]

§ 218.155 Requirements for monitoring and reporting.

(a) *Unauthorized take.* Navy personnel 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 serious injury of any marine mammals, or in any Level A harassment or Level B harassment of marine mammals not authorized under this subpart.

(b) *Monitoring and reporting under the LOA.* The Navy must conduct all monitoring and reporting required under the LOA, including abiding by the U.S. Navy's Marine Species Monitoring Program. Details on program goals, objectives, project selection process, and current projects are available at *www.navymarinespeciesmonitoring.us.*

(c) *Notification of injured, live stranded, or dead marine mammals.* Navy personnel must consult the Notification and Reporting Plan, which sets out notification, reporting, and other requirements when dead, injured, or live stranded marine mammals are detected. The Notification and Reporting Plan is available at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities.*

(d) *Annual GOA Marine Species Monitoring Report.* The Navy must submit an annual report of the GOA Study Area monitoring, which will be included in a Pacific-wide monitoring report and include results specific to the GOA Study Area, describing the implementation and results from the previous calendar year. Data collection methods must be standardized across Pacific Range Complexes including the Mariana Islands Training and Testing (MITT), Hawaii-Southern California Training and Testing (HSTT), Northwest Training and Testing (NWTT), and Gulf of Alaska (GOA) Study Areas to allow for comparison among different geographic locations. The report must be submitted to the Director, Office of Protected Resources, NMFS, either within 3 months after the end of the calendar year, or within 3 months after the conclusion of the monitoring year, to be determined by the adaptive management process. NMFS will submit comments or questions on the 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 submittal if NMFS does not provide comments on the report. This report will describe progress of knowledge made with respect to intermediate scientific objectives within the GOA Study Area associated with the Integrated Comprehensive Monitoring Program (ICMP). Similar study questions must be treated together so that progress on each topic can 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. This will continue to allow the Navy to provide a cohesive monitoring report covering multiple ranges (as per ICMP goals), rather than entirely separate reports for the GOA, NWTT, HSTT, and MITT Study Areas.

(e) *GOA Annual Training Report.* Each year in which training activities are conducted in the GOA Study Area, the Navy must submit one preliminary report (Quick Look Report) to NMFS detailing the status of applicable sound sources within 21 days after the completion of the training activities in the GOA Study Area. Each year in which activities are conducted, the Navy must also submit a detailed report (GOA Annual Training Report) to the Director, Office of Protected Resources, NMFS, within 3 months after completion of the training activities. NMFS must submit comments or questions on the report, if any, within one month of receipt. The report will be considered final after the Navy has addressed NMFS' comments, or one month after submittal if NMFS does not provide comments on the report. The annual reports must contain information about the Major Training Exercise (MTE), including the information listed in paragraphs (e)(1) and (2) of this section. The annual report, which is only required during years in which activities are conducted, must also contain cumulative sonar and explosive use quantity from previous years' reports through the current year. Additionally, if there were any changes to the sound source allowance in the reporting year, or cumulatively, the report must include a discussion of why the change was made and include analysis to support how the change did or did not affect the analysis in the GOA SEIS/OEIS and MMPA final rule. The analysis in the detailed report must be based on the accumulation of data from the current year's report and data collected from previous annual reports. The final annual/close-out report at the conclusion of the authorization period (year seven) will also serve as the comprehensive close-out report and include both the final year annual use compared to annual authorization as well as a cumulative 7-year annual use compared to 7-year authorization. This report must also note any years in which training did not occur. NMFS must 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 if NMFS does not provide comments. Information included in the annual reports may be used to inform future adaptive management of activities within the GOA Study Area. In addition to the information discussed above, the GOA Annual Training Report must include the following information.

(1) *MFAS/HFAS.* The Navy must submit the following information for the MTE conducted in the GOA Study Area.

(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 where mitigation was implemented:*

(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.g., sonar or Lookout).*

(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 was less than 200 yd (182.9 m), 200 to 500 yd (182.9 to 457.2 m), 500 to 1,000 yd (457.2 to 914.4 m), 1,000 to 2,000 yd (914.4 to 1,828.8 m), or greater than 2,000 yd (1,828.8 m) from sonar source.*

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

(L) *Bearing, direction, and motion.* 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) *Mitigation effectiveness evaluation.* 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) *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 hours.* Total annual hours or quantity (per the LOA) of each bin of sonar or other non-impulsive source; and

(B) *Number of explosives.* Total annual number of each type of explosive exercises and total annual expended/detonated rounds (bombs, large-caliber projectiles) for each explosive bin.

§ 218.156 Letters of Authorization.

(a) To incidentally take marine mammals pursuant to this subpart, the Navy must apply for and obtain an LOA in accordance with § 216.106 of this chapter.

(b) An LOA, unless suspended or revoked, may be effective for a period of time not to exceed the expiration date of this subpart.

(c) If an LOA expires prior to the expiration date of this subpart, the Navy may apply for and obtain a renewal of the LOA.

(d) In the event of projected changes to the activity or to mitigation, monitoring, or reporting (excluding changes made pursuant to the adaptive management provision of § 218.157(c)(1)) required by an LOA issued under this subpart, the Navy must apply for and obtain a modification of the LOA as described in § 218.157.

(e) Each LOA will set forth:

(1) Permissible methods of incidental taking;

(2) Geographic areas for incidental taking;

(3) Means of effecting the least practicable adverse impact (*i.e.,* mitigation) on the species and stocks of marine mammals and their habitat; and

(4) Requirements for monitoring and reporting.

(f) Issuance of the LOA will be based on a determination that the level of taking is consistent with the findings made for the total taking allowable under this subpart.

(g) Notice of issuance or denial of the LOA will be published in the **Federal Register** within 30 days of a determination.

§ 218.157 Renewals and modifications of Letters of Authorization.

(a) An LOA issued under §§ 216.106 of this chapter and 218.156 for the activity identified in § 218.150(c) may be renewed or modified upon request by the applicant, provided that:

(1) The planned specified activity and mitigation, monitoring, and reporting measures, as well as the anticipated impacts, are the same as those described and analyzed for this subpart (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section); and

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

(b) For LOA modification or renewal requests by the applicant that include changes to the activity or to the mitigation, monitoring, or reporting measures (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section) that do not change the findings made for this subpart or result in no more than a minor change in the total estimated number of takes (or distribution by species or stock or years), NMFS may publish a notice of planned LOA in the **Federal Register**, including the associated analysis of the change, and solicit public comment before issuing the LOA.

(c) An LOA issued under §§ 216.106 of this chapter and 218.156 may be modified by NMFS under the following circumstances:

(1) After consulting with the Navy regarding the practicability of the modifications, NMFS may modify (including adding or removing measures) the existing mitigation, monitoring, or reporting measures 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, or reporting measures in an LOA include:

(A) Results from the 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 this subpart or a subsequent LOA.

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

(2) 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 LOAs issued pursuant to §§ 216.106 of this chapter and 218.156, an LOA may be modified without prior notice or opportunity for public comment. Notice would be published in the **Federal Register** within 30 days of the action.

§ 218.158 [Reserved]

[FR Doc. 2022–16509 Filed 8–10–22; 8:45 am]

BILLING CODE 3510–22–P