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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648- XA792

Takes of Marine Mammals Incidental to Specified Activities; Physical Oceanographic Studies in the Southwest Indian Ocean, January through February, 2012

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

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received an application from the United States Navy (Navy) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting physical oceanographic studies in the southwest Indian Ocean, January through February, 2012. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to the Navy to incidentally harass, by Level B harassment only, 29 species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than [insert date 30 days after date of publication in the FEDERAL REGISTER].

ADDRESSES: Comments on the application should be addressed to P. Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is ITP.Magliocca@noaa.gov. NMFS is not responsible for e-mail comments send to addresses other than the one provided here. Comments sent via email, including all attachments, must not exceed a 10-megabyte file size.

All comments received are a part of the public record and will generally be posted to http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

An electronic copy of the application containing a list of the references used in this document may be obtained by writing to the above address, telephoning the contact listed here (see FOR FURTHER INFORMATION CONTACT) or visiting the internet at: http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.

In accordance with Executive Order 12114, the Navy has prepared a draft Overseas Environmental Assessment (OEA), which is also available on the internet. Documents cited in this notice may be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Michelle Magliocca, Office of Protected Resources, NMFS, (301) 427-8401.

SUPPLEMENTARY INFORMATION:

Background

Section 101(a)(5)(D) of the Marine Mammal Protect Act of 1972, as amended (MMPA; 16 U.S.C. 1361 et seq.) directs the Secretary of Commerce to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

Authorization for the incidental taking of small numbers of marine mammals shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The authorization must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat, and requirements pertaining to the mitigation, monitoring and reporting of such takings. NMFS has defined "negligible impact" in 50 CFR 216.103 as "…an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) of the MMPA establishes a 45-day time limit for NMFS' review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of small numbers of marine mammals. Within 45 days of the close of the public comment period, NMFS must either issue or deny the authorization. NMFS must publish a notice in the Federal Register within 30 days of its determination to issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

> any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

NMFS received an application on August 15, 2011, from the Navy for the taking of marine mammals, by Level B harassment, incidental to conducting physical oceanographic studies in the southwest Indian Ocean. The Navy plans to conduct a seismic oceanographic survey from January 23, 2012, through February 8, 2012. Upon receipt of additional information, NMFS determined the application complete and adequate on September 14, 2011.

The Navy plans to use one source vessel, the R/V Melville (Melville), and a seismic airgun array to obtain high resolution imaging of ocean mixing dynamics at the Agulhas Return Current and Antarctic Circumpolar Currents (ARC/ACC). The Melville would spend 14 days on seismic oceanography surveys and three days on acoustic Doppler current profiler (ADCP) mooring deployments and recoveries, other oceanographic sampling methods, and transit to and from the study site.

Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the airgun array may have the potential to cause a short-term behavioral disturbance for marine mammals in the survey area. This is the principal means of marine mammal taking associated with these activities, and the Navy has requested an authorization to take 29 species of marine mammals by Level B harassment. Take is not expected to result from the use of the multibeam echosounder (MBES), subbottom profiler (SBP), or ADCPs, due to the narrow and directional acoustic beam field of the MBES, the attenuation rate of high-frequency sound in seawater, and the motility of free-ranging marine mammals. Take is also not expected to result from collision with the Melville because it is a single vessel moving at relatively slow speeds during seismic acquisition within the survey, for a relatively short period of time.

Description of the Specified Activity

The Navy's proposed physical oceanographic studies are scheduled to commence on January 23, 2012, and continue for approximately 17 days ending on February 8, 2012. Some minor deviation from these dates is possible due to logistics and weather conditions; therefore, the authorization would be valid from January 23, 2012 through March 7, 2012. Within this time period, the Navy would conduct seismic oceanography surveys using a towed array of two low-energy 105 in^3 generator-injector (GI) airguns. The Melville would depart from Cape Town, South Africa, on January 23, 2012, and transit to the survey area near the Agulhas Plateau, off the southern tip of Africa. The exact location of the ARC/ACC front in January cannot be predetermined due to the natural meander of the currents, but studies would most likely take place within the boundaries of 36ºS to 43ºS and 19ºE to 30ºE. The exact locations of the ARC/ACC frontal system would be determined on site using high-resolution conductivity-temperature-depth measurements. The total area of this region is about 207,500 nautical $miles^2$ (Nm^2) (713,000 $kilometers^2$ [km^2]). The proposed study would take place in water depths of approximately 1,000 to 5,200 meters (m). The survey would require approximately 17 days to complete approximately 2,489 km of transect lines, and be comprised of multiple transects across and along the ARC/ACC front.

Vessel Specifications

The Melville, owned by the Navy, is a seismic research vessel with a propulsion system designed to be as quiet as possible to avoid interference with the seismic signals emanating from the airgun array. The vessel, which has a length of 97 m (318 feet [ft]); a beam of 14 m (46 ft); and a maximum draft of 5 m (16 ft); is powered by two 1,385 horsepower (hp) Propulsion General Electric motors and a 900 hp retracting bow thruster. The Melville's operation speed during seismic acquisition would be approximately 7 to 11 km/hour (hr) (4 to 6 knots) and the cruising speed of the vessel outside of seismic operations would be about 20 km/hr (11 knots). The vessel also has a platform one deck below and forward of the bridge, which is positioned 12.5 m (41 ft) above the waterline and provides a relatively unobstructed 180 degree view forward. Aft views can be obtained along both the port and starboard decks.

Acoustic Source Specifications

Metrics Used in This Document

This section includes a brief explanation of the sound measurements frequently used in the discussions of acoustic effects in this document. Sound pressure is the sound force per unit area, and is usually measured in micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level (SPL) is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in underwater acoustics is 1 μPa, and the units for SPLs are dB re: 1 μPa.

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

SPL is an instantaneous measurement and can be expressed as the peak, the peak-peak (p-p), or the root mean square (rms). RMS, which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates and all references to SPL in this document refer to the root mean square unless otherwise noted. SPL does not take the duration of a sound into account.

Seismic Airguns

The Melville would deploy two GI guns, which are stainless steel cylinders charged with high pressure air that, when instantaneously released into the water column, generate sound. The GI guns would operate in harmonic mode (105 in^3 in each of the generator and injector chambers for a total discharge volume of 210 in^3) with a 1,200 m long hydrophone streamer. GI guns would be energized simultaneously at 2,000 psi every 17 seconds (s). The GI gun array would emit sound at a frequency range of 10 to 188 Hertz (Hz) and reach a peak source level of 240 dB re 1 μPa. Seismic oceanography studies would be conducted 24 hours (hrs) per day for 14 days (336 hrs) and the GI guns would be towed at a depth of 3 to 9 m.

Characteristics of the Airgun Pulses

Airguns function by venting high-pressure air into the water which creates an air bubble. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by the oscillation of the resulting air bubble. The oscillation of the air bubble transmits sounds downward through the seafloor and the amount of sound transmitted in the near horizontal directions is reduced. However, the airgun array also emits sound that travels horizontally toward non-target areas. The nominal source levels of the airgun array that would be used by the Navy on the Melville are 234 dB re: 1 $\mu Pa_{(0-p)}$ to 240 dB re: 1 $\mu Pa_{(p-p)}$.

Predicted Sound Levels for the Airguns

Lamont-Doherty Earth Observatory (L-DEO) developed a verified model that predicts impulsive sound pressure field propagation and accurately describes acoustic propagation in marine waters of depths greater than 1,000 m. These model-generated sound propagation radii are routinely used for determination of received sound levels generated by impulsive sound sources, and have been previously applied in calculating the total ensonified area for use of two low-energy 105 in^3 GI-guns. Modeled sound propagation radii of GI-gun sources that are the same or similar to the GI-guns used in this study, in water depths >1,000 m, are given in Table 1. These modeled acoustic propagation distances were applied in Environmental Assessments (EAs) and IHAs for seismic surveys conducted in the Eastern Tropical Pacific Ocean (ETP) off of Central America (NMFS, 2004), the Northern Gulf of Mexico (GOMEX) (L-DEO, 2003; NMFS, 2007), and the Arctic Ocean (NMFS, 2006).

For the ETP, one and three 105 in^3 GI-gun arrays were modeled, with a source output level of 241 dB re 1 $\mu Pa_{(0-p)}$ and 247 dB re 1 $\mu Pa_{(p-p)}$. For the GOMEX survey, GI-gun source output levels were (a) 237 dB re 1 $\mu Pa_{(0-p)}$ and 243 dB re 1 $\mu Pa_{(p-p)}$; and (b) 229 dB re 1 $\mu Pa_{(0-p)}$ and 236 dB re 1 $\mu Pa_{(p-p)}$. L-DEO modeling of a single G-gun has also been applied to a seismic survey in the Arctic Ocean. The source level for the 210 in^3 G-gun was 246 dB re 1 $\mu Pa_{(0\text{-}p)}$ and 253 dB re 1 $\mu Pa_{(p\text{-}p)}$. However, because the G-gun generates more energy than a GI-gun of the same size, the distances for received sound levels may be an overestimate for the lower energy dual 105 in^3 GI-gun source used in the ARC12 research project. The GI-gun is comprised of two, independently fired air chambers (the generator and the injector) to tune air bubble oscillation and minimize the amplitude of the acoustic pulse. In contrast, the G-gun is comprised of one chamber and generates a single, less refined injection of air into the water, which produces more acoustic energy than that of the GI-gun.

Air-gun Configuration	Water Depth (m)	Tow Depth (m)	Received Sound Levels (dB re 1 µPa RMS)			
			190	180	160	Location
			Distance			
1 GI-gun 105 in^3	>1,000	2.5	10	27	275	ETP
3 GI-guns 105 in^3	>1,000	2.5	26	82	823	ETP
2 GI-guns 105 in^3 (a)	>1,000	3	20	69	670	GOMEX
2 GI-guns 105 in^3 (b)	>1,000	6	15	50	520	GOMEX
1 G-gun 210 in^3	>1,000	9	20	78	698	Arctic

Table 1. Modeled sound propagation radii for low-energy air-gun arrays for depths >1,000 m.

Based on extant modeling, the proposed sound propagation radii for the two 105 in^3 GI-guns are 20 m, 70 m, and 670 m for the 190, 180, and 160 dB re 1 µPa RMS isopleths, respectively (Table 2). Empirical data indicate that for deep water (>1,000 m), the L-DEO model tends to overestimate the received sound level at a given distance (Tolstoy et al., 2004). It follows that the proposed sound propagation radii are considered conservative, and the actual distance at which received sound levels are 160 dB re 1 uPa RMS or greater are expected to be less than that proposed. The proposed sound propagation radii are also consistent with recent modeling of sound propagation in the Southern Ocean (Breitzke and Bohlen, 2010).

Acoustic Source	Frequency (Hz)	Source Level (dB re 1 µPa)	Received Levels (dB re 1 µPa)		
			190	180	160
			Distance (m)		
2 GI-guns 105 in^3	10-188	~240$_{\text{(peak-to-peak)}}$	20	70	670

Table 2. Sound propagation radii for the dual 105 in^3 GI-gun array proposed for use in the ARC12 research project.

Considering the circumference of the area ensonified to the 160 dB isopleth extends to 1,340 m (twice the 670 m radius); that the GI-gun array is towed approximately 2-9 m below the surface at a speed of 4 knots (7.4 km/hr), and that the seismic oceanographic surveys would be conducted for 14 days for 24 hrs/day, the Navy estimates that the seismic oceanographic survey distance would encompass 1,344 Nm (2,489 km). Multiplying the total linear distance of the seismic oceanographic survey by the area ensonified to the 160 dB isopleth (1,340 m), yields a total ensonified area of approximately 3,335 km^2.

Ocean Surveyor ADCP

A hull-mounted Teledyne RD Instruments Ocean Surveyor ADCP (TRDI OS ADCP) would be operated at 38 kHz with acoustic output pressure of 224 dB re 1 µPa. The beamwidth would be 30 degrees off nadir and the acoustic pressure along each beam is estimated at 180 dB re 1 µPa at 114 m. The TRDI OS ADCP would operate concurrently with the GI-gun array and intermittently to map the distribution of water currents and suspended materials in the water column.

Lowered ADCP (L-ADCP)

A lowered Teledyne RD Instruments ADCP (L-ADCP) would be mounted on a rosette with a conductivity-temperature-depth gauge. The beamwidth would be 30 degrees off nadir and the output pressure would be 216 dB re 1 µPa at 300 kHz. The L-ADCP would be deployed intermittently to collect hydrographic data.

Moored ADCP

Up to four long-range ADCPs (LR-ADCPs) would be anchored on the seafloor using 400 kilograms (kg) of scrap iron (assemblage of four scrap locomotive wheels). LR-ADCPs would be moored to the seafloor at an estimated 3,000 m, such that they float at a depth of 500 m below the sea surface. LR-ADCPs would be suspended from the iron anchorage assemblies by a single line comprised of ¾-inch (in) nylon line and ½-in wire rope. The LR-ADCPs and suspension line would be recovered at the close of the study via an acoustic release and the iron anchorage assembly would remain on the sea floor. The acoustic source frequency would be 75 kHz with an output pressure level of 200 dB re 1 μPa at a rate of once per second. The beamwidth would be four degrees and directed vertically upward at 20 degrees. LR-ADCPs would be moored several kilometers apart, in the area of the ARC/ACC frontal system, with exact mooring locations to be determined onsite due to the natural meander of the currents and front. LR-ADCPs would operate continuously for the estimated 14 days of research before being recovered.

Multibeam Echosounder

The Melville would operate a hull-mounted Kongsberg EM 122 multibeam echosounder (MBES) at 10.5 to 13 kilohertz (kHz). The MBES would generate acoustic pulses in a downward fan-shaped beam, one degree fore-aft and 150 degrees athwartship. For deep water operations, each "ping" is comprised of eight (>1,000 m depth; 3,280 ft) or four (<1,000 m depth; 3,280 ft) successive acoustic transmissions 2 to 100 milliseconds (ms) in duration. The maximum sound pressure output level would be 242 dB re 1 μPa.

Sub-bottom Profiler

The Melville would also operate a Knudsen 320B/R sub-bottom profiler (SBP). The SBP is dual-frequency and operates at 3.5 and 12 kHz with maximum power outputs of 10 kilowatts (kW) and 2 kW, respectively. The pulse length used during this study would be 0.8 to 24 ms, relative to water depth and sediment characteristics. The pulse repetition rates would be between 0.5 and 2 seconds (s) in shallow water and up to 8 s in deep water. A common operational mode is broadcast of five pulses at 1-s intervals followed by a 5-s delay. Maximum acoustic output pressure would be 211 dB re 1 μPa at 3.5 kHz; however, systems are typically used at 80 percent capacity. The SPB emits a downward conical beam with a width of about 30 degrees.

Description of the Marine Mammals in the Area of the Proposed Specified Activity

Forty marine mammal species are known to inhabit waters between South Africa and Antarctica. Six of these species are listed as endangered under the U.S. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) and depleted under the MMPA, including the southern right (Eubalaena australis), humpback (Megaptera novaeangliae), sei (Balaenoptera borealis), fin (Balaenoptera physalus), blue (Balaenoptera musculus), and sperm (Physeter macrocephalus) whales. Most of the species occurring in the area spend the austral summer in preferred Antarctic habitats, and the austral winter in areas northward around the east and west coasts of Africa, South America, Australia, and islands of the Indian Ocean. The cape fur seal is the only pinniped known to have breeding colonies along the southern coast of Africa. It is not listed as threatened or endangered under the ESA. Cape fur seals are endemic to South Africa, with colonies on islands and patches of mainland along the southern coast.

Table 3 provides estimates of the average (best) and maximum marine mammal population densities in the area of the proposed study during the austral summer, anticipated occurrence of each species in the area of research during that time, primary habitat(s), and ESA listing status.

Table 3. Habitat, regional abundance, and conservation status of marine mammals that may occur in or near the proposed seismic survey areas off southern Africa in the southwest Indian Ocean.
[See text and Tables 2.0-2.2 in the Navy's application and environmental analysis for further details.]

Species	Occurrence in Survey Area during the Austral Summer	Habitat	ESA [1]	Density Best	Density Max
Mysticetes					
Antarctic minke whale	Rare	Pelagic and coastal	NL	<0.01	0.01
Blue whale	Rare	Pelagic and coastal	E	<0.01	<0.01
Bryde's whale	Common	Pelagic and coastal	NL	<0.01	<0.01
Common minke whale	Rare	Pelagic and coastal	NL	0.03	0.05

Species	Occurrence in Survey Area during the Austral Summer	Habitat	ESA [1]	Density Best	Max
Fin whale	Rare	Continental shelf and slope and pelagic	E	<0.01	0.01
Humpback whale	Rare	Mainly nearshore waters and banks	E	<0.01	<0.01
Sei whale	Rare	Pelagic	E	<0.01	<0.01
Odontocetes Arnoux's beaked whale	Rare	Deep water	NL	<0.01	0.01
Cuvier's beaked whale	Common	Pelagic	NL	<0.01	<0.01
Dwarf sperm whale	Indeterminate	Continental shelf an deep water	NL	<0.01	<0.01
Gray's beaked whale	Rare	Deep water	NL	<0.01	<0.01
Hector's beaked whale	Rare	Deep water	NL	<0.01	<0.01
Pygmy right whale	Indeterminate	Continental shelf	NL	<0.01	<0.01
Pygmy sperm whale	Indeterminate	Continental shelf and deep water		<0.01	<0.01
Southern bottlenose whale	Rare	Deep water	NL	0.01	0.01
Southern right whale	Common	Coastal and pelagic	E	<0.01	<0.01
Sperm whale	Common	Pelagic and deep water	E	0.01	0.01
Strap-toothed whale	Common	Deep water	NL	<0.01	<0.01
True's beaked whale	Common	Deep water	NL	<0.01	<0.01
Common bottlenose dolphin	Common	Coastal and pelagic		0.04	0.10
Dusky dolphin	Rare	Coastal and pelagic	NL	<0.01	<0.01
False killer whale	Indeterminate	Pelagic	NL	<0.01	<0.01
Fraser's dolphin	n/a	Deep water	NL	n/a	n/a
Heaviside's dolphin	Rare	Coastal and deep water	NL	<0.01	0.01
Hourglass dolphin	Rare	Coastal and pelagic	NL	<0.01	<0.01
Indo-pacific bottlenose dolphin	n/a	Coastal and continental shelf	NL	n/a	n/a
Indo-pacific hump-backed dolphin	n/a	Coastal	NL	n/a	n/a
Killer whale	Common	Ubiquitous	NL	0.01	0.01
Long-beaked common dolphin	Common	Coastal and continental shelf	NL	<0.01	<0.01

Species	Occurrence in Survey Area during the Austral Summer	Habitat	ESA [1]	Density Best	Max
Long-finned pilot whale	Rare	Continental shelf and slope and pelagic	NL	0.05	0.10
Pantropical spotted dolphin	Indeterminate	Coastal and pelagic	NL	0.01	0.01
Pygmy killer whale	Rare	Deep water	NL	<0.01	<0.01
Risso's dolphin	Common	Deep water	NL	0.06	0.10
Rough-toothed dolphin	Rare	Deep water	NL	<0.01	<0.01
Short-beaked common dolphin	Common	Continental shelf and slope and pelagic	NL	0.24	0.38
Short-finned pilot whale	Rare	Pelagic	NL	0.03	0.04
Southern right whale dolphin	Common	Deep water	NL	0.01	0.02
Spinner dolphin	Common	Coastal and pelagic	NL	<0.01	0.01
Striped dolphin	Common	Continental shelf and slope and pelagic	NL	0.19	0.31
Pinnipeds Cape fur seal	Rare	Islands and mainland	NL	0.04	n/a

n/a Not available or not assessed.
[1] U.S. Endangered Species Act: EN = Endangered, T = Threatened, NL = Not listed.
[18] Galapagos Islands (Alava and Salazar, 2006).

Refer to section 2.0 of the Navy's application for detailed information regarding the abundance and distribution, population status, and life history and behavior of these species and their occurrence in the proposed project area. The application also presents how the Navy calculated the estimated densities for the marine mammals in the proposed survey area. While Table 3 lists all 40 species known to inhabit the proposed survey area, the Navy is only requesting take authorization for 29 species. The Navy does not anticipate take, nor is NMFS proposing to authorize take, for the following species: blue whale, Bryde's whale, dwarf sperm whale, pygmy right whale, pygmy sperm whale, dusky dolphin, Fraser's dolphin, heaviside's dolphin, Indo-Pacific bottlenose dolphin, Indo-Pacific hump-backed dolphin, and Cape fur seal. This is based on population density estimates for cetaceans and the total ensonified area of the proposed activity. Cape fur seals are not expected to be harassed because their primary habitat is among the bays of the South African coastline, more than 30 Nm away from the proposed survey activities.

Potential Effects of the Specified Activity on Marine Mammals

Acoustic stimuli generated by the operation of airguns, which introduce sound into the marine environment, may have the potential to cause Level B harassment of marine mammals in the proposed survey area. The effects of sounds from airgun operations might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent impairment, or non-auditory physical or physiological effects (Richardson et al., 1995; Gordon et al., 2004; Nowacek et al., 2007; Southall et al., 2007).

Permanent hearing impairment, in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not considered an injury but rather a type of Level B harassment (Southall et al., 2007). Although the possibility cannot be entirely excluded, it is unlikely that the proposed project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. Based on the available data and studies described here, some behavioral disturbance is expected, but NMFS expects the disturbance to be localized and short-term.

Tolerance to Sound

Studies on marine mammal tolerance to sound in the natural environment are relatively rare. Richardson et al. (1995) defines tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or man-made noise. In many cases, tolerance develops by the animal habituating to the stimulus (i.e., the gradual waning of responses to a repeated or ongoing stimulus) (Richardson et al., 1995; Thorpe, 1963), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson et al., 1995).

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Malme et al., (1985) studied the responses of humpback whales on their summer feeding grounds in southeast Alaska to seismic pulses from a airgun with a total volume of 100-in^3. They noted that the whales did not exhibit persistent avoidance when exposed to the airgun and concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB: re 1 μPa.

Weir (2008) observed marine mammal responses to seismic pulses from a 24-airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. She recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent).

Masking of Natural Sounds

The term masking refers to the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus (Clark et al., 2009). Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid other noise is important in communication, predator and prey detection, and, in the case of toothed whales, echolocation. Introduced underwater sound may, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson et al., 1995). Even in the absence of manmade sounds, the sea is usually noisy. Background ambient noise often interferes with or masks the ability of an animal to detect a sound signal even when that signal is above its absolute hearing threshold. Natural ambient noise includes contributions from wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal noise resulting from molecular agitation (Richardson et al., 1995). Background noise can also include sounds from human activities. Masking of natural sounds can result when human activities produce high levels of background noise. Conversely, if the background level of underwater noise is high, (e.g., on a day with strong wind and high waves), an anthropogenic noise source will not be detectable as far away as would be possible under quieter conditions and will itself be masked.

Masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited. Because of the intermittent nature and low duty cycle of seismic airgun pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in some situations, reverberation occurs for much or the entire interval between pulses (e.g., Simard et al., 2005; Clark and Gagnon, 2006) which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls can usually be heard between the seismic pulses (e.g., Richardson et al., 1986; McDonald et al., 1995; Greene et al., 1999; Nieukirk et al., 2004; Smultea et al., 2004; Holst et al., 2005a,b, 2006; and Dunn and Hernandez, 2009). However, Clark and Gagnon (2006) reported that fin whales in the northeast Pacific Ocean went silent for an extended period starting soon after the onset of a seismic survey in the area. Similarly, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles et al., 1994). However, more recent studies found that they continued calling in the presence of seismic pulses (Madsen et al., 2002; Tyack et al., 2003; Smultea et al., 2004; Holst et al., 2006; and Jochens et al., 2008). Dolphins and porpoises commonly are heard calling while airguns are operating (e.g., Gordon et al., 2004; Smultea et al., 2004; Holst et al., 2005a, b; and Potter et al., 2007). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking.

Although some degree of masking is inevitable when high levels of manmade broadband sounds are introduced into the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Structured signals, such as the echolocation click sequences of small toothed whales, may be readily detected even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore, 1988, 1990). The components of background noise that are similar in frequency to the sound signal in question primarily determine the degree of masking of that signal.

There is evidence of other marine mammal species continuing to call in the presence of industrial activity. For example, bowhead whale calls are frequently detected in the presence of seismic pulses, although the number of calls detected may sometimes be reduced (Richardson et al., 1986; Greene et al., 1999; Blackwell et al., 2009). Additionally, annual acoustical monitoring near BP's Northstar production facility during the fall bowhead migration westward through the Beaufort Sea has recorded thousands of calls each year (for examples, see Richardson et al., 2007; Aerts and Richardson, 2008). Construction, maintenance, and operational activities have been occurring from this facility for more than 10 years. To compensate and reduce masking, some mysticetes may alter the frequencies of their communication sounds (Richardson et al., 1995a; Parks et al., 2007). Masking processes in baleen whales are not amenable to laboratory study, and no direct measurements on hearing sensitivity are available for these species. It is not currently possible to determine with precision the potential consequences of temporary or local background noise levels. However, Parks et al. (2007) found that right whales altered their vocalizations, possibly in response to background noise levels. For species that can hear over a relatively broad frequency range, as is presumed to be the case for mysticetes, a narrow band source may only cause partial masking. Richardson et al. (1995a) note that a bowhead whale 20 km (12.4 mi) from a human sound source, such as that produced during oil and gas industry activities, might hear strong calls from other whales within approximately 20 km (12.4 mi), and a whale 5 km (3.1 mi) from the source might hear strong calls from whales within approximately 5 km (3.1 mi). Additionally, masking is more likely to occur closer to a sound source, and distant anthropogenic sound is less likely to mask short-distance acoustic communication (Richardson et al., 1995a).

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 sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson et al., 1995). 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 noises by improving the effective signal-to-noise ratio. In the cases of high-frequency hearing by the bottlenose dolphin, beluga whale, and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Penner et al., 1986; Dubrovskiy, 1990; Bain et al., 1993; Bain and Dahlheim, 1994). Toothed whales, and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient noise toward frequencies with less noise (Au et al., 1974, 1985; Moore and Pawloski, 1990; Thomas and Turl, 1990; Romanenko and Kitain, 1992; Lesage et al., 1999). A few marine mammal species are known to increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim, 1987; Au, 1993; Lesage et al., 1993, 1999; Terhune, 1999; Foote et al., 2004; Parks et al., 2007, 2009; Di Iorio and Clark, 2009; Holt et al., 2009).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva et al. (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Directional hearing has been demonstrated at frequencies as low as 0.5-2 kHz in several marine mammals, including killer whales (Richardson et al., 1995). This ability may be useful in reducing masking at these frequencies. In summary, high levels of noise generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies. For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

In general, NMFS expects the masking effects of seismic pulses to be minor, given the normally intermittent nature of seismic pulses, the frequency and output pressure of the dual GI-guns, and the likelihood that marine mammals may avoid the sound source.

Behavioral Disturbance

Behavioral disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Marine mammal reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al., 1995; Wartzok et al., 2004; Southall et al., 2007; Weilgart, 2007). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder, 2007; Weilgart, 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals would be present within a particular proximity to activities and/or exposed to a particular level of sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically-important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically-important degree by a seismic program are based primarily on behavioral observations of a few species. Scientists have conducted detailed studies on humpback, gray, bowhead (Balaena mysticetus), and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species there are no data on responses to marine seismic surveys.

Baleen Whales – Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable (reviewed in Richardson et al., 1995). Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals (Richardson et al., 1995); they simply avoided the sound source by altering their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re: 1 μPa seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (Malme et al., 1986, 1988; Richardson et al., 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from four to 15 km from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong behavioral reactions to the airgun array.

McCauley et al. (1998, 2000) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678-in^3) and to a single airgun (20-in^3) with source level of 227 dB re: 1 $\mu Pa_{(p-p)}$. In the 1998 study, they documented that avoidance reactions began at five to eight km from the array, and that those reactions kept most pods approximately three to four km from the operating seismic boat. In the 2000 study, they noted localized displacement during migration of four to five km by traveling pods and seven to 12 km by more sensitive resting pods of cow-calf pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 μPa for humpback pods containing females, and at the mean closest point of approach distance the received level was 143 dB re: 1 μPa. The initial avoidance response generally occurred at distances of five to eight km from the airgun array and two km from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100 to 400 m (328 to 1,312 ft), where the maximum received level was 179 dB re: 1 μPa.

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64-L (100-in^3) airgun (Malme et al., 1985). Some humpbacks seemed "startled" at received levels of 150 to 169 dB re: 1 μPa. Malme et al. (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB re: 1 μPa.

Studies have suggested that south Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al., 2004). The evidence for this was circumstantial and subject to alternative explanations (IAGC, 2004). Also, the evidence was not consistent with subsequent results from the same area of Brazil (Parente et al., 2006), or with direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was no observable direct correlation between strandings and seismic surveys (IWC, 2007:236).

There are no data on reactions of right whales to seismic surveys, but results from the closely-related bowhead whale show that their responsiveness can be quite variable depending on their activity (migrating versus feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20 to 30 km from a medium-sized airgun source at received sound levels of around 120 to 130 dB re: 1 μPa (Miller et al., 1999; Richardson et al., 1999; see Appendix B (5) of L-DEO's environmental analysis). However, more recent research on bowhead whales (Miller et al., 2005; Harris et al., 2007) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. Nonetheless, subtle but statistically significant changes in surfacing-respiration-dive cycles were evident upon statistical analysis (Richardson et al., 1986). In the summer, bowheads typically begin to show avoidance reactions at received levels of about 152 to 178 dB re: 1 μPa (Richardson et al., 1986, 1995; Ljungblad et al., 1988; Miller et al., 2005).

Reactions of migrating and feeding (but not wintering) gray whales to seismic surveys have been studied. Malme et al. (1986, 1988) studied the responses of feeding eastern Pacific gray whales to pulses from a single 100-in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales stopped feeding at an average received pressure level of 173 dB re: 1 μPa on an (approximate) rms basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re: 1 μPa. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme et al., 1984; Malme and Miles, 1985), and western Pacific gray whales feeding off Sakhalin Island, Russia

(Wursig et al., 1999; Gailey et al., 2007; Johnson et al., 2007; Yazvenko et al., 2007a, b), along with data on gray whales off British Columbia (Bain and Williams, 2006).

Various species of Balaenoptera (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses (Stone, 2003; MacLean and Haley, 2004; Stone and Tasker, 2006), and calls from blue and fin whales have been localized in areas with airgun operations (e.g., McDonald et al., 1995; Dunn and Hernandez, 2009). Sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. silent (Stone, 2003; Stone and Tasker, 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (Stone and Tasker, 2006). In a study off of Nova Scotia, Moulton and Miller (2005) found little difference in sighting rates (after accounting for water depth) and initial sighting distances of balaenopterid whales when airguns were operating vs. silent. However, there were indications that these whales were more likely to be moving away when seen during airgun operations. Similarly, ship-based monitoring studies of blue, fin, sei and minke whales offshore of Newfoundland (Orphan Basin and Laurentian Sub-basin) found no more than small differences in sighting rates and swim directions during seismic versus non-seismic periods (Moulton et al., 2005, 2006a,b).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in Malme et al., 1984; Richardson et al., 1995; Allen and Angliss, 2010). The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year (Johnson et al., 2007). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson et al., 1987; Angliss and Allen, 2009).

Toothed Whales – Little systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above have been reported for toothed whales. However, there are recent systematic studies on sperm whales (e.g., Gordon et al., 2006; Madsen et al., 2006; Winsor and Mate, 2006; Jochens et al., 2008; Miller et al., 2009). There is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone, 2003; Smultea et al., 2004; Moulton and Miller, 2005; Bain and Williams, 2006; Holst et al., 2006; Stone and Tasker, 2006; Potter et al., 2007; Hauser et al., 2008; Holst and Smultea, 2008; Weir, 2008; Barkaszi et al., 2009; Richardson et al., 2009).

Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Goold, 1996a, b, c; Calambokidis and Osmek, 1998; Stone, 2003; Moulton and Miller, 2005; Holst et al., 2006; Stone and Tasker, 2006; Weir, 2008; Richardson et al., 2009; see also Barkaszi et al., 2009). Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing (e.g., Moulton and Miller, 2005). Similarly, recent empirical observations indicate that delphinids have been frequently observed within the 160 dB isopleth during seismic survey operations (LGL 2009, 2010b). Nonetheless, small toothed whales more often tend to head away, or to maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Stone and Tasker, 2006; Weir, 2008). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km less, and some individuals show no apparent avoidance. The beluga whale (Delphinapterus leucas) is a species that (at least at times) shows long-distance avoidance of seismic vessels. Aerial surveys conducted in the southeastern Beaufort Sea during summer found that sighting rates of beluga whales were significantly lower at distances 10 to 20 km compared with 20 to 30 km from an operating airgun array, and observers on seismic boats in that area rarely see belugas (Miller et al., 2005; Harris et al., 2007).

Captive bottlenose dolphins (Tursiops truncatus) and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al., 2000, 2002, 2005). However, the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses (e.g., Stone, 2003; Moulton et al., 2005, 2006a; Stone and Tasker, 2006; Weir, 2008). In most cases the whales do not show strong avoidance, and they continue to call. However, controlled exposure experiments in the Gulf of Mexico indicate that foraging behavior was altered upon exposure to airgun sound (Jochens et al., 2008; Miller et al., 2009; Tyack, 2009).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. However, some northern bottlenose whales (Hyperoodon ampullatus) remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (Gosselin and Lawson, 2004; Laurinolli and Cochrane, 2005; Simard et al., 2005). Most beaked whales tend to avoid approaching vessels of other types (e.g., Wursig et al., 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya, 1986), although it is uncertain how much longer such dives may be as compared to dives by undisturbed beaked whales, which also are often quite long (Baird et al., 2006; Tyack et al., 2006). Based on a single observation, Aguilar-Soto et al. (2006) suggested that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly.

There are increasing indications that some beaked whales tend to strand when naval exercises involving mid-frequency sonar operation are ongoing nearby (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; NOAA and USN, 2001; Jepson et al., 2003; Hildebrand, 2005; Barlow and Gisiner, 2006; see also the Stranding and Mortality section in this notice). These strandings are apparently a disturbance response, although auditory or other injuries or other physiological effects may also be involved. Whether beaked whales would ever react similarly to seismic surveys is unknown. Seismic survey sounds are quite different from those of the sonar in operation during the above-cited incidents.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and other odontocetes.

Hearing Impairment and Other Physical Effects

Exposure to high intensity sound for a sufficient duration may result in auditory effects such as a noise-induced threshold shift – an increase in the auditory threshold after exposure to noise

(Finneran, Carder, Schlundt, and Ridgway, 2005). Factors that influence the amount of threshold shift include the amplitude, duration, frequency content, temporal pattern, and energy distribution of noise exposure. The magnitude of hearing threshold shift normally decreases over time following cessation of the noise exposure. The amount of threshold shift just after exposure is called the initial threshold shift. If the threshold shift eventually returns to zero (i.e., the threshold returns to the pre-exposure value), it is called temporary threshold shift (TTS) (Southall et al., 2007). Researchers have studied TTS in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall et al., 2007). However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., permanent threshold shift (PTS), in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Temporary Threshold Shift – TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days, can be limited to a particular frequency range, and can be in varying degrees (i.e., a loss of a certain number of dBs of sensitivity). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall et al. (2007). As illustrated previously in Table 2, the Melville's airguns are expected to reach or exceed 180 dB re: 1 μPa at 70 m (230 ft).

To avoid the potential for injury, NMFS (1995, 2000) concluded that cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re: 1 μPa. The established 180-dB re 1 μPa (rms) criterion is the received level above which, in the view of a panel of bioacoustics specialists convened by NMFS before additional TTS measurements for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. TTS is considered by NMFS to be a type of Level B (non-injurious) harassment. The 180-dB level is a shutdown criterion applicable to cetaceans, as specified by NMFS (2000) and is used to establish an exclusion zone (EZ), as appropriate. NMFS also assumes that cetaceans exposed to levels exceeding 160 dB re: 1 μPa (rms) may experience Level B harassment.

Researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. For the one harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke et al., 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (cf. Southall et al., 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison, 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales (Southall et al., 2007).

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. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that takes place during a time when the animal is traveling through the open ocean, where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication. The fact that animals exposed to levels and durations of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature is also notable and potentially of more importance than the simple existence of a TTS. For this proposed study, the Navy expects cases of TTS to be improbable given: (1) the slow speed of the vessel during survey activities; (2) the motility of free-ranging marine mammals in the water column; and (3) the propensity for marine mammals to avoid obtrusive sounds.

Permanent Threshold Shift – When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al., 1995, p. 372ff; Gedamke et al., 2008). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise time. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably greater than six dB (Southall et al., 2007).

Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS would occur during the Navy's proposed activity. Baleen whales generally avoid the immediate area around operating seismic vessels, as do some other marine mammals.

Non-auditory Physiological Effects – Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance, and other types of organ or tissue damage (Cox et al., 2006; Southall et al., 2007). Studies examining such effects are limited. However, resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum et al., 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might perhaps result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses.

In general, very little is known about the potential for seismic survey sounds (or other types of strong underwater sounds) to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow 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 those ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales and some odontocetes, are especially unlikely to incur non-auditory physical effects.

Stranding and Mortality

Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten et al., 1993; Ketten, 1995). However, explosives are no longer used for marine waters for commercial seismic surveys or (with rare exceptions) for seismic research; they have been replaced entirely by airguns or related non-explosive pulse generators. Airgun pulses are less energetic and have slower rise times, and there is no specific evidence that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of strandings of beaked whales with naval exercises involving mid-frequency active sonar and, in one case, an L-DEO seismic survey (Malakoff, 2002; Cox et al., 2006), has raised the possibility that beaked whales exposed to strong "pulsed" sounds may be especially susceptible to injury and/or behavioral reactions that can lead to stranding (e.g., Hildebrand, 2005; Southall et al., 2007).

Specific sound-related processes that lead to strandings and mortality are not well documented, but may include:

(1) Swimming in avoidance of a sound into shallow water;

(2) A change in behavior (such as a change in diving behavior) that might contribute to tissue damage, gas bubble formation, hypoxia, cardiac arrhythmia, hypertensive hemorrhage or other forms of trauma;

(3) A physiological change such as a vestibular response leading to a behavioral change or stress-induced hemorrhagic diathesis, leading in turn to tissue damage; and

(4) Tissue damage directly from sound exposure, such as through acoustically-mediated bubble formation and growth or acoustic resonance of tissues. Some of these mechanisms are unlikely to apply in the case of impulse sounds. However, there are increasing indications that gas-bubble disease (analogous to the bends), induced in supersaturated tissue by a behavioral response to acoustic exposure, could be a pathologic mechanism for the strandings and mortality of some deep-diving cetaceans exposed to sonar. Still, the evidence for this remains circumstantial and associated with exposure to naval mid-frequency sonar, not seismic surveys (Cox et al., 2006; Southall et al., 2007).

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below one kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of two to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (e.g., Balcomb and Claridge, 2001; NOAA and USN, 2001; Jepson et al., 2003; Fernández et al., 2004, 2005; Hildebrand 2005; Cox et al., 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity "pulsed" sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al., 2004) were not well founded (IAGC, 2004; IWC, 2007). In September 2002, there was a stranding of two Cuvier's beaked whales (Ziphius cavirostris) in the Gulf of California, Mexico, when the L-DEO vessel R/V Maurice Ewing was operating a 20-airgun (8,490 in^3) array in the general area. The link between the stranding and the seismic survey was inconclusive and not based on any physical evidence (Hogarth, 2002; Yoder, 2002). Nonetheless, the Gulf of California incident plus the beaked whale strandings near naval exercises involving use of mid-frequency sonar suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand, 2005). No injuries of beaked whales are anticipated during the proposed study because of:

(1) The high likelihood that any beaked whales nearby would avoid the approaching vessel

before being exposed to high sound levels,

(2) Differences between the sound sources operated from the Melville and those involved in the naval exercises associated with strandings.

Potential Effects of Other Acoustic Devices

As previously mentioned, the Kongsberg EM 122 MBES generates short acoustic pulses for 2 to 100 ms every 1.5 to 20 s, depending on water depth. Acoustic output frequency is 12 kHz and the maximum source level is 242 dB re 1 µPa.m. The Knudsen 320B/R SBP generates short acoustic pulses of 0.8 to 24 ms at 0.5 to 8 s intervals. Pulse frequency is 3.5 kHz and the maximum source level is 211 dB re 1 µPa.m. The TRDI OS ADCP would operate at 38 kHz with sound output pressure level of 224 dB re 1 µP.m, producing a ping every 0.2 to 6 s. L-ADCPs would operate at 300 kHz with an output pressure level of 216 dB re 1 µP.m. Moored L-R ADCPs would operate at 75 kHz with an output pressure level of 200 dB re 1 µP.m and pulse interval of 2 s.

The MBES, SBP, and TRDI OS ADCP would operate from the Melville during the proposed study to verify seafloor conditions and collect additional seafloor bathymetric data. The MBES and SBP would operate continuously, and concurrent, with airgun operations. The TRDI OS ADCP would operate intermittently to map the distribution of water currents and suspended materials in the water column, and would also operate concurrent with the dual GI-gun array. The moored LR-ADCPs would operate continuously for approximately 14 days, and L-ADCPs deployed intermittently, to collect hydrographic data.

Marine mammals would need to be within 100 m of the hull mounted MBES (highest acoustic pressure) to experience a received level of ~185 dB re 1 µPa2.s and the potential for TTS. If exposed to the MBES or SBP, it is unlikely that animals would be ensonified for more than a single pulse of >10 ms, given the narrowness of the acoustic beamwidths of all instruments, and mobile nature of the vessel and free-ranging marine mammals. Kremser et al. (2005) concluded that an animal would have to pass through the area ensonified by an MBES/SBP transducer at close range, and be moving at a speed and bearing similar to that of the vessel to be subjected to the multiple pulses and sound levels sufficient to cause harm. Similarly, Burkhardt et al. (2007) suggest that auditory injury is possible only if a cetacean dove into the immediate vicinity of a transducer. Standard echosounding instruments, such as the MBES and SBP, are considered to present a low risk of TTS or auditory injury, given that an individual would have to be within the acoustic beam field, ~10 m or less from the transducer, and receive exposure to 250 to 1000 acoustic pulses to be at risk for TTS (Boebel et al., 2004). Based in part on the foregoing discussion, NMFS has determined that brief exposure of marine mammals to a single pulse, or small numbers of pulses from an MBES or SBP, is not likely to result in the harassment of marine mammals (NMFS 2010a, b, 2011b).

The shipboard TRDI OS ADCP operates at similar frequencies and duty cycles, generates a relatively narrow beamwidth, and is not expected to pose any significant risk to marine mammals for the same reasons that MBES and SBP present a low risk of harassment. In summary, due to (a) the narrow and directional acoustic beam fields of these instruments; (b) the relatively high frequencies of the MBES, SBP and TRDI OS ADCP; (c) the motility of both free-ranging marine animals and the vessel; and (d) the fact that an animal's bearing and speed would need to parallel that of the vessel to receive exposure to sound pressure for any significant period of time; harassment of marine mammals is considered to be of low probability. The likelihood of hearing impairment and other physiological effects occurring is considered to be very low.

The LR- and L-ADCP source frequencies of 75 kHz and 300 kHz, respectively, are also not expected to pose any significant risk to marine mammals. Neither of the ADCP output frequencies overlap the predominant communication frequencies employed by mysticetes (upper hearing threshold of mysticetes is ~30 kHz), which would preclude any significant masking in these species. The L-ADCP generates sound at 300 kHz, which is inaudible to marine mammals. The moored LR-ADCPs would operate at a depth of about 500 m (1640 feet), which exceeds the average diving depths of the majority of marine mammals in the research area. Of the deep diving marine mammals, beaked whales (recorded at depths of 2,000 m) have peak auditory sensitivity between 5 kHz and 80 kHz. Hence, the 75 kHz tone generated by the LR-ADCPs would be at the upper limit of the beaked whales hearing threshold, and not expected to pose a significant risk in terms of TTS or PTS, or result in significant behavioral responses. The sperm whale (recorded at depths of 3,000 m) generates clicks in the 2 to 4 kHz and 10 to16 kHz frequency ranges. No direct testing of hearing has been performed on sperm whales, although it is assumed sperm whales hear at the same frequencies at which they vocalize. As such, significant exposure of sperm whales to the LR-ADCP sound sources would not be expected to occur. Sound generated by the LR-ADCPs is above the auditory threshold of humpback and southern right whales. The fin whale has a known maximum dive depth of 500 m, although the mean depth of dives is substantially less. Given these factors, the fairly rapid attenuation of high-frequency sound in seawater, and the motility of free-ranging marine mammals in the water column, significant exposure of marine mammals to the LR- and L-ADCPs is expected to be of low probability.

Considering the foregoing factors discussed, the potential for the adverse effects of masking, tolerance, TTS/PTS, and non-auditory physiological injury as a result of operation of the MBES, SBP, TRDI OS ADCP, LR-ADCP or L-ADCP is considered to be very low. Marine mammal communication and hearing is not expected to be significantly masked by these instruments, given the relatively low duty cycles and brief period of exposure an individual marine mammal may receive if transiting an acoustic beam field. Any behavioral reactions that result from exposure to these sources are anticipated to be short-term, and limited to avoidance of the sound source.

Based on this assessment, previously conducted oceanographic research using same or similar instrumentation and procedures and environmental studies associated with these previous actions (e.g., NMFS 2004, 2010a, b), and current literature (Boebel et al. 2004; Breitzke and Bohlen 2010; Costa et al. 2003; Kastak et al. 2005; Popper 2008; Popper and Hastings 2009a; Richardson et al. 1995; Tyack 2008, 2009), operation of the MBES, SBP, TRDI OS ADCP and deployed ADCPs is not expected to result in any significant adverse impact on marine mammals, their habitats, or food sources. Of the potential adverse effects, short-term behavioral responses primarily in the way of avoidance of the vessel, LR-ADCPs, and L-ADCPs is considered the only type of effect that will likely occur as a result of operation of these acoustic sources.

The potential effects to marine mammals described in this section of the document do not take into consideration the proposed monitoring and mitigation measures described later in this document (see the "Proposed Mitigation" and "Proposed Monitoring and Reporting" sections).

Anticipated Effects on Marine Mammal Habitat

The proposed seismic survey will not result in any permanent impact on habitats used by the marine mammals in the proposed survey area, including the food sources they use (i.e. fish and invertebrates), and there will be no physical damage to any habitat. While it is anticipated that the specified activity may result in marine mammals avoiding certain areas due to temporary ensonification, this impact to habitat is temporary and reversible and was considered in further detail earlier in this document, as behavioral modification. The main impact associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, previously discussed in this notice.

Anticipated Effects on Fish

One reason for the adoption of airguns as the standard energy source for marine seismic surveys is that, unlike explosives, they have not been associated with large-scale fish kills. However, existing information on the impacts of seismic surveys on marine fish populations is limited. There are three types of potential effects of exposure to seismic surveys: (1) pathological, (2) physiological, and (3) behavioral. Pathological effects involve lethal and temporary or permanent sub-lethal injury. Physiological effects involve temporary and permanent primary and secondary stress responses, such as changes in levels of enzymes and proteins. Behavioral effects refer to temporary and (if they occur) permanent changes in exhibited behavior (e.g., startle and avoidance behavior). The three categories are interrelated in complex ways. For example, it is possible that certain physiological and behavioral changes could potentially lead to an ultimate pathological effect on individuals (i.e., mortality).

The specific received sound levels at which permanent adverse effects to fish potentially could occur are little studied and largely unknown. Furthermore, the available information on the impacts of seismic surveys on marine fish is from studies of individuals or portions of a population; there have been no studies at the population scale. The studies of individual fish have often been on caged fish that were exposed to airgun pulses in situations not representative of an actual seismic survey. Thus, available information provides limited insight on possible real-world effects at the ocean or population scale.

Hastings and Popper (2005), Popper (2009), and Popper and Hastings (2009a, b) provided recent critical reviews of the known effects of sound on fish. The following sections provide a general synopsis of the available information on the effects of exposure to seismic and other anthropogenic sound as relevant to fish. The information comprises results from scientific studies of varying degrees of rigor plus some anecdotal information. Some of the data sources may have serious shortcomings in methods, analysis, interpretation, and reproducibility that must be considered when interpreting their results (Hastings and Popper, 2005). Potential adverse effects of the program's sound sources on marine fish are then noted.

Pathological Effects – The potential for pathological damage to hearing structures in fish depends on the energy level of the received sound and the physiology and hearing capability of the species in question. For a given sound to result in hearing loss, the sound must exceed, by some substantial amount, the hearing threshold of the fish for that sound (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish on a fish population are unknown; however, they likely depend on the number of individuals affected and whether critical behaviors involving sound (e.g., predator avoidance, prey capture, orientation and navigation, reproduction, etc.) are adversely affected.

Little is known about the mechanisms and characteristics of damage to fish that may be inflicted by exposure to seismic survey sounds. Few data have been presented in the peer-reviewed scientific literature. As far as we know, there are only two papers with proper experimental methods, controls, and careful pathological investigation implicating sounds produced by actual seismic survey airguns in causing adverse anatomical effects. One such study indicated anatomical damage, and the second indicated TTS in fish hearing. The anatomical case is McCauley et al. (2003), who found that exposure to airgun sound caused observable anatomical damage to the auditory maculae of pink snapper (Pagrus auratus). This damage in the ears had not been repaired in fish sacrificed and examined almost two months after exposure. On the other hand, Popper et al. (2005) documented only TTS (as determined by auditory brainstem response) in two of three fish species from the Mackenzie River Delta. This study found that broad whitefish (Coregonus nasus) exposed to five airgun shots were not significantly different from those of controls. During both studies, the repetitive exposure to sound was greater than would have occurred during a typical seismic survey. However, the substantial low-frequency energy produced by the airguns [less than 400 Hz in the study by McCauley et al. (2003) and less than approximately 200 Hz in Popper et al. (2005)] likely did not propagate to the fish because the water in the study areas was very shallow (approximately nine m in the former case and less than two m in the latter). Water depth sets a lower limit on the lowest sound frequency that will propagate (the "cutoff frequency") at about one-quarter wavelength (Urick, 1983; Rogers and Cox, 1988).

Wardle et al. (2001) suggested that in water, acute injury and death of organisms exposed to seismic energy depends primarily on two features of the sound source: (1) the received peak pressure and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. According to Buchanan et al. (2004), for the types of seismic airguns and arrays involved with the proposed program, the pathological (mortality) zone for fish would be expected to be within a few meters of the seismic source. Numerous other studies provide examples of no fish mortality upon exposure to seismic sources (Falk and Lawrence, 1973; Holliday et al., 1987; La Bella et al., 1996; Santulli et al., 1999; McCauley et al., 2000a,b, 2003; Bjarti, 2002; Thomsen, 2002; Hassel et al., 2003; Popper et al., 2005; Boeger et al., 2006).

Some studies have reported, some equivocally, that mortality of fish, fish eggs, or larvae can occur close to seismic sources (Kostyuchenko, 1973; Dalen and Knutsen, 1986; Booman et al., 1996; Dalen et al., 1996). Some of the reports claimed seismic effects from treatments quite different from actual seismic survey sounds or even reasonable surrogates. However, Payne et al. (2009) reported no statistical differences in mortality/morbidity between control and exposed groups of capelin eggs or monkfish larvae. Saetre and Ona (1996) applied a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae. They concluded that mortality rates caused by exposure to seismic surveys are so low, as compared to natural mortality rates, that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

Physiological Effects – Physiological effects refer to cellular and/or biochemical responses of fish to acoustic stress. Such stress potentially could affect fish populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses of fish after exposure to seismic survey sound appear to be temporary in all studies done to date (Sverdrup et al., 1994; Santulli et al., 1999; McCauley et al., 2000a, b). The periods necessary for the biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects – Behavioral effects include changes in the distribution, migration, mating, and "catchability" of fish populations. Studies investigating the possible effects of sound (including seismic survey sound) on fish behavior have been conducted on both uncaged and caged individuals (e.g., Chapman and Hawkins, 1969; Pearson et al., 1992; Santulli et al., 1999; Wardle et al., 2001; Hassel et al., 2003). Typically, in these studies fish exhibited a sharp startle response at the onset of a sound followed by habituation and a return to normal behavior after the sound ceased.

There is general concern about potential adverse effects of seismic operations on fisheries, namely a potential reduction in the catchability of fish involved in fisheries. Although reduced catch rates have been observed in some marine fisheries during seismic testing, in a number of cases the findings are confounded by other sources of disturbance (Dalen and Raknes, 1985; Dalen and Knutsen, 1986; Lokkeborg, 1991; Skalski et al., 1992; Engas et al., 1996). In other airgun experiments, there was no change in catch per unit effort (CPUE) of fish when airgun pulses were emitted, particularly in the immediate vicinity of the seismic survey (Pickett et al., 1994; La Bella et al., 1996). For some species, reductions in catch may have resulted from a change in behavior of the fish, e.g., a change in vertical or horizontal distribution, as reported in Slotte et al. (2004).

In general, any adverse effects on fish behavior or fisheries attributable to seismic testing may depend on the species in question and the nature of the fishery (season, duration, fishing method). They may also depend on the age of the fish, its motivational state, its size, and numerous other factors that are difficult, if not impossible, to quantify at this point, given such limited data on effects of airguns on fish, particularly under realistic at-sea conditions.

Anticipated Effects on Invertebrates

The existing body of information on the impacts of seismic survey sound on marine invertebrates is very limited. However, there is some unpublished and very limited evidence of the potential for adverse effects on invertebrates, thereby justifying further discussion and analysis of this issue. The three types of potential effects of exposure to seismic surveys on marine invertebrates are pathological, physiological, and behavioral. Based on the physical structure of their sensory organs, marine invertebrates appear to be specialized to respond to particle displacement components of an impinging sound field and not to the pressure component (Popper et al., 2001).

The only information available on the impacts of seismic surveys on marine invertebrates involves studies of individuals; there have been no studies at the population scale. Thus, available information provides limited insight on possible real-world effects at the regional or ocean scale. The most important aspect of potential impacts concerns how exposure to seismic survey sound ultimately affects invertebrate populations and their viability, including availability to fisheries.

Literature reviews of the effects of seismic and other underwater sound on invertebrates were provided by Moriyasu et al. (2004) and Payne et al. (2008). The following sections provide a synopsis of available information on the effects of exposure to seismic survey sound on species of decapod crustaceans and cephalopods, the two taxonomic groups of invertebrates on which most such studies have been conducted. The available information is from studies with variable degrees of scientific soundness and from anecdotal information.

Pathological Effects – In water, lethal and sub-lethal injury to organisms exposed to seismic survey sound appears to depend on at least two features of the sound source: (1) the received peak pressure; and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. For the type of airgun array planned for the proposed survey, the pathological (mortality) zone for crustaceans and cephalopods is expected to be less than a few meters of the seismic source; however, very few specific data are available on levels of seismic signals that might damage these animals. This premise is based on the peak pressure and rise/decay time characteristics of seismic airgun arrays currently in use around the world.

Some studies have suggested that seismic survey sound has a limited pathological impact on early developmental stages of crustaceans (Pearson et al., 1994; Christian et al., 2003; DFO, 2004). However, the impacts appear to be either temporary or insignificant compared to what occurs under natural conditions. Controlled field experiments on adult crustaceans (Christian et al., 2003, 2004; DFO, 2004) and adult cephalopods (McCauley et al., 2000a,b) exposed to seismic survey sound have not resulted in any significant pathological impacts on the animals. It has been suggested that exposure to commercial seismic survey activities has injured giant squid (Guerra et al., 2004), but the article provides little evidence to support this claim.

Physiological Effects – Physiological effects refer mainly to biochemical responses by marine invertebrates to acoustic stress. Such stress potentially could affect invertebrate populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses (i.e., changes in haemolymph levels of enzymes, proteins, etc.) of crustaceans have been noted several days or months after exposure to seismic survey sounds (Payne et al., 2007). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects – There is increasing interest in assessing the possible direct and indirect effects of seismic and other sounds on invertebrate behavior, particularly in relation to the consequences for fisheries. Changes in behavior could potentially affect such aspects as reproductive success, distribution, susceptibility to predation, and catchability by fisheries. Studies investigating the possible behavioral effects of exposure to seismic survey sound on crustaceans and cephalopods have been conducted on both uncaged and caged animals. In some cases, invertebrates exhibited startle responses (e.g., squid in McCauley et al., 2000a, b; juvenile cuttlefish in Komak et al. 2005). In other cases, no behavioral impacts were noted (e.g., crustaceans in Christian et al., 2003, 2004; DFO 2004). There have been anecdotal reports of reduced catch rates of shrimp shortly after exposure to seismic surveys; however, other studies have not observed any significant changes in shrimp catch rate (Andriguetto-Filho et al., 2005). Similarly, Parry and Gason (2006) did not find any evidence that lobster catch rates were affected by seismic surveys. Any adverse effects on crustacean and cephalopod behavior or fisheries attributable to seismic survey sound depend on the species in question and the nature of the fishery (season, duration, fishing method). In general, data on which to assess the potential adverse effects of GI-gun sounds on invertebrate species is rather ambiguous; however, of the limited data available, crustaceans and cephalopods appear sensitive and responsive to the frequencies of sound generated by airguns, although at sound pressures somewhat higher than that for marine mammals.

In conclusion, NMFS has preliminarily determined that the Navy's proposed marine seismic survey is not expected to have any habitat-related effects that could cause significant or long-term consequences for marine mammals or on the food sources that they utilize.

Proposed Mitigation

In order to issue an incidental take authorization (ITA) under section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and the availability of such species or stock for taking for certain subsistence uses.

The Navy has proposed the following mitigation measures to be implemented for the proposed seismic survey:

Exclusion Zones

The Navy used the exposure threshold isopleths applicable to cetaceans (there is no proposed take for pinnipeds), as well as extant models of same/similar GI-gun sources and water depths, as the basis for their exclusion zones. The proposed exclusion zone is 70 m for the 180 dB exposure thresholds and would be employed for monitoring.

Speed or Course Alteration

If a marine mammal is observed moving on a path toward an exclusion zone, an attempt would be made to adjust the vessel speed or course in order to minimize the likelihood of an animal entering an exclusion zone. Speed and course alterations are not always possible when towing a long GI-gun array, but are considered possible options given the use of a dual GI-gun array.

Shut-down Procedures

The Navy proposes to shut down the operating airgun array if a marine mammal is seen within or approaching an exclusion zone. The Navy would implement a shut-down if a cetacean is observed within or approaching the 180 dB isopleth (70 m). Airgun activity would not resume until the marine mammal has cleared the exclusion zone or has not been seen for 15 (dolphins) to 30 minutes (whales).

Ramp-up Procedures

Ramp-up would be comprised of gradually activating the dual GI-guns in sequence over a period of about 30 min until the desired operating level is reached. This should allow any marine mammals in the area to avoid the maximum sound source. Airguns would be activated in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per 5-min periods over a total duration of 30 min. During ramp-up, protected species observers would monitor the exclusion zones for marine mammals and a shutdown would be implemented if an animal is detected in or approaching an exclusion zone.

NMFS has carefully evaluated the applicant's proposed mitigation measures and has considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Based on our evaluation of the applicant's proposed measures, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impacts on marine mammals species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking." The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for IHAs 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 in the action area.

Monitoring

The Navy proposes to sponsor marine mammal monitoring during the proposed activity, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA. The Navy's proposed Monitoring Plan is described below this section. The Navy understands that this monitoring plan will be subject to review by NMFS, and that refinements may be required.

Vessel-based Visual Monitoring

The Navy proposes to continuously monitor the harassment isopleths during daytime and nighttime airgun operations. Visual monitoring would be comprised of three protected species observers (PSOs) typically working in shift of 4-hr durations or less. A PSO platform is located one deck below and forward of the bridge (12. 5 m [41 ft] above the waterline), providing a relatively unobstructed 180 degree view forward. Aft views can be obtained along both the port and starboard decks. During daytime operations, PSOs would systematically survey the area around the vessel with reticle and big-eye binoculars and the naked eye. A clinometer would be used to determine distances of animals in close proximity to the vessel, and hand-held fixed rangefinders and distance marks on the Melville's side rails would be used to measure the exact location of the exclusion zones. During nighttime operations, night vision devices would be available if required.

The PSOs would be in wireless communication with ship's officers on the bridge and scientists in the vessel's operations laboratory, so they can promptly advise of the need for avoidance maneuvers or seismic source shutdown. Shutdown of GI-gun operations would occur immediately upon observation/detection of any marine mammal in an exclusion zone. Following a shutdown, GI-gun ramp-up would not be initiated until PSOs have confirmed the marine mammal is no longer observed/detected for a period of 15 or 30 minutes (depending on species). If a marine mammal is outside of an exclusion zone and observed by a PSO to exhibit abnormal behaviors consistent with signs of harassment (e.g., avoidance, dive patterns, multiple changes in direction), operation of the GI-guns would cease until the animal moves out of the area or is not resighted for a period of 30 min.

PSO Data and Documentation

PSOs will record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data will be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They will also provide information needed to order a power down or shut down of the airguns when a marine mammal is within or nearing the exclusion zone.

When a sighting is made, the following information will be recorded:

1. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare;
2. Species, group size, age, individual size, sex (if determinable);
3. Behavior when first sighted and subsequent behaviors;
4. Bearing and distance from the vessel, sighting cue, exhibited reaction to the airgun sounds or vessel (e.g., none, avoidance, approach, etc.), behavioral pace, and depth at time of detection;
5. Fin/fluke characteristics and angle of fluke when an animal submerges to determine if the animal executed a deep or surface dive;
6. Type and nature of sounds heard; and
7. Any other relevant information.

When shutdown is required for mitigation purposes, the following information will be recorded:

1. The basis for decisions resulting in shutdown of the GI-guns;

2. Information needed to estimate the number of marine mammals potentially taken by harassment;

3. Information on the frequency of occurrence, distribution, and activities of marine mammals in the study area;

4. Information on the behaviors and movements of marine mammals during and without operation of the GI-guns; and

5. Any adverse effects the shutdown had on the research.

PSOs would provide estimates of the numbers of marine mammals exposed to the GI-gun source and any disturbance reactions exhibited, or the lack thereof. Observations and data collection would aim to provide estimates of the actual numbers of animals taken, verify the level of harassment, aide in assessment of impacts on populations on conclusion of the study, and increase knowledge of species in the study area. Observations and data collection would also aim to provide information that would allow for verifying or disputing that the takings are negligible.

Reporting Measures

The Navy would submit a report to NMFS within 90 days after the end of the cruise. The report would describe the operations that were conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report would also include estimates of the number and nature of exposures that could result in “takes” of marine mammals.

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA (if issued), such as an injury (Level A harassment), serious injury, or mortality (e.g., ship-strike, gear interaction, and/or entanglement), the Navy would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS. The report must include the following information:

● Time, date, and location (latitude/longitude) of the incident;

● Name and type of vessel involved;

● Vessel's speed during and leading up to the incident;

● Description of the incident;

● Status of all sound source use in the 24 hrs preceding the incident;

● Water depth;

● Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);

● Description of all marine mammal observations in the 24 hrs preceding the incident;

● Species identification or description of the animal(s) involved;

● Fate of the animal(s); and

● Photographs or video footage of the animal(s) (if equipment is available).

Activities would not resume until NMFS is able to review the circumstances of the prohibited take. NMFS would work with the Navy to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The Navy may not resume their activities until notified by NMFS via letter, email, or telephone.

In the event that the Navy discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), the Navy would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS. The report must include the same information identified in the paragraph above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS would work with the Navy to determine whether modifications in the activities are appropriate.

In the event that the Navy discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Navy would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS within 24 hrs of the discovery. The Navy would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

> any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Only take by Level B harassment is anticipated and proposed to be authorized as a result of the proposed physical oceanographic survey off the southern coast of Africa. Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the dual airgun array may have the potential to cause marine mammals in the survey area to be exposed to sounds at or greater than 160 dB or cause temporary, short-term changes in behavior. There is no evidence that the planned activities would result in injury, serious injury, or mortality within the specified geographic area for which the Navy seeks the IHA. The mitigation and monitoring measures proposed for implementation are expected to minimize any potential risk for injury or mortality.

The following sections describe the Navy's methods to estimate take by incidental harassment and present the applicant's estimates of the numbers of marine mammals that could be taken during the proposed physical oceanographic survey. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the GI-gun array to be used during multiple transects totaling approximately 2,489 km (1,547 mi).

The Navy assumes that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES and SBP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP given their characteristics (e.g., narrow downward-directed beam) and other considerations described previously. Therefore, the Navy provides no additional allowance for animals that could be affected by sound sources other than airguns.

Density estimates on the marine mammal species in the proposed survey area are based on data derived from a number of sources: the Ocean Biogeographic Information System OBIS Seamap (OBIS-SEAMP); the International Union for Conservation of Nature (IUCN, 2010); the Convention on the Conservation of Migratory Species of Wild Animals (CMS, 2010); NatureServe Explorer (NatureServe, 2010); the International Whaling Commission (IWC);

NOAA Fisheries Office of Protected Resources; and the Navy Marine Species Density Database (NMSDD); unless otherwise cited. The NMSDD includes the highest quality, spatially modeled, density data where data is available. For all other geographic areas, data were evaluated using a hierarchical approach and a review process to incorporate the best data available. The NMSDD incorporates density from global predictive relative environmental suitability models for geographic areas where no survey data or density estimates exist. The global predictive estimates for areas beyond survey coverage are available in two forms: (1) Sea Mammal Research Unit Limited (SMRUL) that includes survey-based density estimates in the prediction of densities estimated elsewhere within Food and Agriculture Organization (FAO) areas; and (2) predictions from Kristin Kaschner which are based on using relative environmental suitability as an index in conjunction with a global mean population estimate determined from literature (Kaschner et al., 2006). The resulting data within the NMFSDD provide the best available, single density value for a selected geographic area and time.

One method of estimating takes assumes marine mammals are uniformly distributed throughout a given area, although this is not representative of the real world distribution of marine mammals in any given geographic region. Marine mammals are typically found grouped in pods, concentrate around preferred breeding and foraging habitats, and most species follow seasonal migratory patterns and routes. However, due to lack of substantive information on marine mammal population distributions and densities in the area of the proposed action, informed assumptions on distribution patterns cannot be made, and exposure estimates are based on uniform distribution of marine mammals over the area for which population data are available. Bearing these factors in mind, the exposure estimates provided are considered reasonable approximations of potential exposure, and based on the best available information available.

Marine mammal population density estimates for the area and time of year of study provide species of cetacea that would be expected to be present in the study area during the time research activities would be conducted. Many species are unlikely to be significantly populous in the proposed area of study during the research time frame, as the austral summer migration finds many of the migratory species in the Antarctic waters of the Southern Ocean in Antarctic waters, typically south of 40°S. The only known commonly sighted whales year-round off the South African coast is an in-shore sub-species of Bryde's whale and the Southern right whale. In general, whales are most populous in the study area during the austral winter months, from approximately June to November, and populations are at their lowest during the austral summer.

Table 3 provides estimates of the minimum, average (considered the best estimate), and maximum marine mammal population densities in the area of the proposed study during the austral summer, anticipated occurrence of each species, and requested take authorization. For all species evaluated, average population density estimates were used for calculation of the number of marine mammals that may be exposed. NMFS has used average (or best) population density estimates when analyzing the allowable harassment for ESA-listed marine mammals incidental to marine seismic surveys for scientific research purposes (e.g., see NMFS 2010c, 2011c). The results of the monitoring reports from those surveys, and others, show that the use of the average estimate is appropriate for provision of reasonable estimates of exposure and harassment. Requested takes estimates are based on Navy exposure criteria, which determines take at 0.5 animals exposed for non ESA-listed marine mammals, and 0.05 animals exposed for ESA-listed species. In other words, if 0.5-0.9 non-ESA animals are expected to be exposed to sounds above 160 dB, the value is rounded up to one; for ESA-listed animals, the value is rounded up to one if

0.05-0.9 individuals are expected to be exposed to sounds above 160 dB.

Because extant mathematical models poorly simulate and predict the natural meander of the AC, ARC, and ARC/ACC frontal system, and due to unpredictable weather conditions, it is not possible to accurately predict the exact location where seismic oceanographic survey transects would occur. For this reason, the minimum, average, and maximum population densities given in Table 3 are the mean of the population densities for each species within the coordinates of 36°S to 43°S, and 19°E to 30°E. Therefore, the mean of the minimum, average, and maximum marine mammal population density values for each square kilometer of this region were used in order to (1) capture the uncertainty as to exactly where the SO survey will take place, and (2) the inherent uncertainty in marine mammal population density estimates. The front is estimated to be phase-locked between 36°S to 40°S, and 21°E to 27°E; however, the position of the front can vary by up to 100 km (generally west, east, and south of this estimated location). Because the precise location of the seismic oceanography survey transects cannot be known in advance, it is not possible to accurately differentiate the numbers of marine mammals that may be exposed in waters of the global commons (high seas), as opposed to within the South African exclusive economic zone (EEZ). Because the specific location of research activities cannot be predetermined, due to the variables described, this assessment conservatively estimates that all exposures occur in waters of the global commons (high seas) where estimated population density estimates are higher.

Based on the best available population density estimates, 2,410 cetacea may potentially be exposed to sound pressure levels ≥160 dB re 1 μPa.rms. Of the total number of cetaceans that are estimated to be exposed, 60 are listed as endangered under the ESA: 29 fin (<0.2% of the southern hemisphere population), 1 humpback (<0.004% of the southern hemisphere population), 10 sei (<0.2% of the population south of 30°S), 1 southern right (<0.004% of the southern hemisphere population), and 19 sperm (<0.02% of the southern hemisphere population) whales. For all species, the number of individuals that would be exposed to sounds ≥160 dB re 1 μPa.rms is less than 0.2 percent of the given species' population for which regional population density estimates are known.

Species	**ESA** [1]	**Density** Best	Min	Max	**Requested take**
Mysticetes					
Antarctic minke whale	NL	<0.01	<0.01	0.01	14
Blue whale	E	<0.01	<0.01	<0.01	0
Bryde's whale	NL	<0.01	<0.01	<0.01	0
Common minke whale	NL	0.03	0.02	0.05	103
Fin whale	E	0.01	<0.01	0.01	29
Humpback whale	E	<0.01	<0.01	<0.01	1
Sei whale	E	<0.01	<0.01	<0.01	10
Odontocetes					
Arnoux's beaked whale	NL	<0.01	<0.01	0.01	15
Cuvier's beaked whale	NL	<0.01	<0.01	<0.01	12
Dwarf sperm whale	NL	<0.01	<0.01	<0.01	0
Gray's beaked whale	NL	<0.01	<0.01	<0.01	11
Hector's beaked whale	NL	<0.01	<0.01	<0.01	9
Pygmy right whale	NL	<0.01	<0.01	<0.01	0
Pygmy sperm whale	NL	<0.01	<0.01	<0.01	0
Southern bottlenose whale	NL	<0.01	<0.01	0.01	21
Southern right whale	E	<0.01	<0.01	<0.01	1
Sperm whale	E	0.01	<0.01	0.01	19
Strap-toothed whale	NL	<0.01	<0.01	<0.01	9
True's beaked whale	NL	<0.01	<0.01	<0.01	10

Species	ESA [1]	Density Best	Min	Max	Requested take
Common bottlenose dolphin	NL	0.04	0.01	0.10	141
Dusky dolphin	NL	<0.01	<0.01	<0.01	0
False killer whale	NL	<0.01	<0.01	<0.01	1
Fraser's dolphin	NL	n/a	n/a	n/a	0
Heaviside's dolphin	NL	<0.01	<0.01	0.01	0
Hourglass dolphin	NL	<0.01	<0.01	<0.01	3
Indo-pacific bottlenose dolphin	NL	n/a	n/a	n/a	0
Indo-pacific hump-backed dolphin	NL	n/a	n/a	n/a	0
Killer whale	NL	0.01	<0.01	0.01	30
Long-beaked common dolphin	NL	<0.01	<0.01	<0.01	1
Long-finned pilot whale	NL	0.05	<0.01	0.10	180
Pantropical spotted dolphin	NL	0.01	<0.01	0.01	20
Pygmy killer whale	NL	<0.01	<0.01	<0.01	1
Risso's dolphin	NL	0.06	0.04	0.10	210
Rough-toothed dolphin	NL	<0.01	<0.01	<0.01	2
Short-beaked common dolphin	NL	0.24	0.13	0.38	799
Short-finned pilot whale	NL	0.03	0.01	0.04	86
Southern right whale dolphin	NL	0.01	<0.01	0.02	29
Spinner dolphin	NL	<0.01	<0.01	0.01	16
Striped dolphin	NL	0.19	0.03	0.31	626
Pinnipeds Cape fur seal	NL	0.04	n/a	n/a	0

Table 3. Estimated number of marine mammals exposed to ≥160 dB during the proposed activity.

Exposure estimates are based on marine mammal population density estimates relative to the total area ensonified by the GI-gun array, and evaluated for exposure to the 160 dB isopleth.

Multiplying the total area ensonified during the seismic oceanography survey by the population estimate for each species, yields the estimated number of marine mammals exposed to sound pressures >160 dB. The total ensonified area is about 3,335 km^2 and assumes no area of overlap during the survey transects, which would cover a total distance of 2,489 km.

Negligible Impact and Small Numbers Analysis and Preliminary Determination

NMFS has defined ‘‘negligible impact’’ in 50 CFR 216.103 as “...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.’’ In making a negligible impact determination, NMFS considers a variety of factors, including but not limited to:

(1) The number of anticipated mortalities;

(2) The number and nature of anticipated injuries;

(3) The number, nature, and intensity, and duration of Level B harassment; and

(4) The context in which the takes occur.

As mentioned previously, NMFS estimates that 29 species of marine mammals could be potentially affected by Level B harassment over the course of the IHA. For each species, these numbers are small (less than one percent) relative to the population size.

No injuries, serious injuries, or mortalities are anticipated to occur as a result of the Navy’s planned physical oceanographic survey, and none are proposed to be authorized by NMFS. Additionally, for reasons presented earlier in this document, temporary hearing impairment (and especially permanent hearing impairment) is not anticipated to occur during the proposed specified activity. Only short-term behavioral disturbance is anticipated to occur due to the brief and sporadic duration of the survey activities. No mortality or injury is expected to occur, and due to the nature, degree, and context of behavioral harassment anticipated, the activity is not expected to impact rates of recruitment or survival.

NMFS has preliminarily determined, provided that the aforementioned mitigation and monitoring measures are implemented, that the impact of conducting a physical oceanographic survey off the southern coast of Africa, January through February, 2012, may result, at worst, in a temporary modification in behavior and/or low-level physiological effects (Level B harassment) of small numbers of certain species of marine mammals.

Of the ESA-listed marine mammals that may potentially occur in the proposed survey area, blue and southern right whale populations are thought to be increasing; population trends for fin, humpback, sei, and sperm whales are not well known in the southern hemisphere. There is no designated critical habitat for marine mammals in the proposed survey area. There are also no important habitat areas (e.g., breeding, calving, feeding, etc.) for marine mammals known around the area that would overlap with the proposed survey. While behavioral modifications, including temporarily vacating the area during the operation of the airgun(s), may be made by these species to avoid the resultant acoustic disturbance, the availability of alternate areas within these areas and the short and sporadic duration of the research activities, have led NMFS to preliminary determine that this action will have a negligible impact on the species in the specified geographic region.

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 mitigation and monitoring measures, NMFS preliminarily finds that the Navy's planned research activities would result in the incidental take of small numbers of marine mammals, by Level B harassment only, and that the total taking from the physical oceanographic survey would have a negligible impact on the affected species or stocks.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

There are no relevant subsistence uses of marine mammals implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act

Of the species of marine mammals that may occur in the proposed survey area, six are listed as endangered under the ESA, including the blue, fin, humpback, sei, southern right, and sperm whales. Under section 7 of the ESA, the Navy has initiated formal consultation with NMFS, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, on this proposed survey. NMFS' Office of Protected Resources, Permits and Conservation Division, has also initiated formal consultation under section 7 of the ESA with NMFS' Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, to obtain a Biological Opinion evaluating the effects of issuing the IHA on threatened and endangered marine mammals and, if appropriate, authorizing incidental take. NMFS will conclude formal section 7 consultation prior to making a determination on whether or not to issue the IHA. If the IHA is issued, the Navy, in addition to the mitigation and monitoring requirements included in the IHA, would be required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion issued to both the Navy and NMFS' Office of Protected Resources, Permits and Conservation Division.

National Environmental Policy Act (NEPA)

The Navy has prepared a draft Overseas Environmental Assessment (OEA) to address the potential environmental impacts that could occur as a result of the proposed activity. To meet NMFS' National Environmental Policy Act (NEPA; 42 U.S.C. 4321 et seq.) requirements for the issuance of an IHA to the Navy, NMFS will either adopt the OEA (if sufficient) or prepare an independent NEPA analysis. This analysis will be completed prior to issuance of a final IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to the Navy for conducting a physical oceanographic survey off the southern coast of Africa, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Date: November 15, 2011.

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