DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XD229

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Geohazard Survey in the Beaufort Sea, Alaska

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 BP Exploration (Alaska) Inc. (BP) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting a shallow geohazard survey in Foggy Island Bay, Beaufort Sea, Alaska, during the 2014 open water season. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to BP to incidentally take, by Level B harassment only, marine mammals during the specified activity.

DATES: Comments and information must be received no later than May 16, 2014.

ADDRESSES: Comments on the application should be addressed to Jolie Harrison, Supervisor, Incidental Take Program, 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.Nachman@noaa.gov.* NMFS is not responsible for email comments sent to addresses other than the one provided here. Comments sent via email, including all attachments, must not exceed a 25-megabyte file size.

Instructions: 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* without change. All Personal Identifying Information (e.g., name, address) 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 address specified above, telephoning the contact listed below (see **FOR FURTHER INFORMATION CONTACT**), or visiting the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm.* Documents cited in this notice may also be viewed, by appointment, during regular business hours, at the aforementioned address.

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

SUPPLEMENTARY INFORMATION:

Background

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

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

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

On February 4, 2014, NMFS received an application from BP for the taking of marine mammals incidental to conducting a shallow geohazard survey. NMFS determined that the application was adequate and complete on March 6, 2014.

BP proposes to conduct a shallow geohazard survey in Federal and state waters of Foggy Island Bay in the Beaufort Sea during the open-water season of 2014. The proposed activity would occur between July 1 and September 30; however, airgun and other sound source equipment operations would cease on August 25. The following specific aspects of the proposed activity are likely to result in the take of marine mammals: airguns and scientific sonars/devices. Take, by Level B harassment only, of 9 marine mammal species is anticipated to result from the specified activity.

Description of the Specified Activity

Overview

BP's proposed shallow geohazard survey would consist of two phases: a site survey and a sonar survey. During the first phase, the Site Survey, the emphasis is on obtaining shallow geohazard data using an airgun array and a towed streamer. During the second phase, the Sonar Survey, data will be acquired both in the Site Survey location and subsea pipeline corridor area (see Figure 1 in BP's application) using the multibeam echosounder, sidescan sonar, subbottom profiler, and the magnetometer. The total discharge volume of the airgun array will not exceed 30 cubic inches (in^3). The program is proposed to be conducted during the 2014 open-water season.

The purpose of the proposed shallow geohazard survey is to evaluate development of the Liberty field. The Liberty reservoir is located in federal waters in Foggy Island Bay about 8 miles (mi) east of the Endicott Satellite Drilling Island. The project's preferred alternative is to build a gravel island situated over the reservoir. In support of the preferred alternative, a Site Survey is planned with an emphasis on obtaining two-dimensional high-resolution (2DHR) shallow geohazard data using an airgun array and a towed streamer. Additional infrastructure required for the preferred alternative would include a subsea pipeline. A Sonar Survey, using multibeam echosounder, sidescan sonar, subbottom profiler, and magnetometer is proposed over the Site Survey location and subsea pipeline corridor area. The purpose of this proposed survey is to evaluate the existence and location of archaeological resources and potential geologic hazards on the seafloor and in the shallow subsurface.

Dates and Duration

The planned start date is approximately July 1, 2014, with data acquisition beginning when open water conditions allow. The survey is expected to take approximately 20 days to complete, not including weather downtime. Each phase of the survey (i.e., site survey and sonar survey) has an expected duration of 7.5 days based on a 24-hour workday. Between the first and second phase, the operations will be focused on changing equipment for about 5 days (i.e., no active sound sources would be used to acquire data during this time). To limit potential impacts to the bowhead whale fall migration and subsistence hunting, airgun and sonar operations will cease by midnight on August 25. Demobilization of equipment would continue after airgun and sonar operations end but would be completed by September 30. Therefore, the proposed dates for the IHA (if issued) are July 1 through September 30, 2014.

Specified Geographic Region

The proposed shallow geohazards survey would occur in Federal and state waters of Foggy Island Bay in the Beaufort Sea, Alaska. The project area lies mainly within the Liberty Unit but also includes portions of the Duck Island Unit, as well as non-unit areas. Figure 1 in BP's application outlines the proposed survey acquisition areas, including proposed boundaries for the two phases of the project. The Phase 1 Site Survey, focused on obtaining shallow geohazard data using an airgun array and towed streamer, will occur within approximately 12 mi². The Phase 2 Sonar Survey will occur over the Site Survey area and over approximately 5 mi² within the 29 mi² area identified in Figure 1 of BP's application. Water depth in this area ranges from about 2–24 ft. Activity outside the area delineated in Figure 1 of BP's application may include vessel turning while using airguns, vessel transit, and other vessel movements for project support and logistics. The approximate boundaries of the two survey areas are between 70°14′10″ N. and 70°20′20″ N. and between 147°29′05″ W. and 148°52′30″ W.

Detailed Description of Activities

The activities associated with the proposed shallow geohazard survey include vessel mobilization, navigation and data management, housing and logistics, and data acquisition.

1. Vessel Mobilization

One vessel will be used for the geohazard survey. The proposed survey vessel (*R/V Thunder* or equivalent) is about 70 × 20 ft in size. This vessel will be transported to the North Slope by truck and prepared and launched at West Dock or Endicott. Vessel preparation includes the assembly of navigation, acoustic, and safety equipment. Initial fueling and stocking of recording equipment will also be part of the vessel preparations. Once assembled, the navigation and acoustic systems will be tested at West Dock or at the project site.

2. Navigation and Data Management

The vessel will be equipped with Differential Global Navigation Satellite System receivers capable of observing dual constellations and backup. Corrected positions will be provided via a precise point positioning solution. A kinematic base station will be kept at the housing facilities in Deadhorse to mitigate against the inability to acquire a precise point positioning signal. Tidal corrections will be determined through Global Navigation Satellite System computation, comparison with any local tide gauges, and, if available, with tide gauges operated by other projects.

A navigation software package will display known obstructions, islands, and identified areas of sensitivity. The software will also show the pre-determined source line positions within the two survey areas. The information will be updated as necessary to ensure required data coverage. The navigation software will also record all measured equipment offsets and corrections and vessel and equipment position at a frequency of no less than once per 5 seconds for the duration of the project.

3. Housing and Logistics

Approximately 20 people will be involved in the operation. Most of the crew will be accommodated at existing camps, and some crew will be housed on the vessel. Support activities, such as crew transfers and vessel re-supply are primarily planned to occur at Endicott and West Dock. However, support activities may also occur at other nearby vessel accessible locations if needed (e.g., East Dock). Equipment staging and onshore support will primarily occur at West Dock but may also take place at other existing road-accessible pads within the Prudhoe Bay Unit area as necessary. For protection from weather, the vessel may anchor near West Dock, near the barrier islands, or other near shore locations.

4. Data Acquisition

Equipment proposed for use during the proposed shallow geohazard survey includes airgun, multibeam echosounder, sidescan sonar, subbottom profiler, and a marine magnetometer. Details related to data acquisition are summarized next.

Survey Design: One vessel will be used for the proposed survey. The proposed vessel (*R/V Thunder* or equivalent) is about 70 × 20 ft in size. The airgun and streamer, sidescan sonar, and magnetometer will be deployed from the vessel. The multibeam echosounder and subbottom profiler will be hull-mounted. No equipment will be placed on the sea floor as part of survey activities.

The survey will acquire data in two phases. During the first phase the emphasis is on obtaining shallow geohazard data in the Site Survey area (see Figure 1 in BP's application) using an airgun array and a towed streamer. During the second phase data will be acquired in both the Site Survey and Sonar Survey areas (see Figure 1 in BP's application) using the multibeam echosounder, sidescan sonar, subbottom profiler, and the magnetometer. Each phase has an expected duration of about 7.5 days, based on a 24-hour workday. Between the first and second phase the operations will be focused on changing equipment for about 5 days.

2DHR Seismic: High-resolution seismic data acquisition will only take place during Phase 1 in the Site Survey area. The 2DHR seismic source will consist of one of two potential arrays, each with a discharge volume of 30 in³ and containing multiple airguns. The first array option will have three 10 in³ airguns, and the other array option will have a 20 in³ and a 10 in³ airgun. Table 1 in this document and BP's application summarizes airgun array specifics for each option. A 5 in³ airgun will be utilized as the mitigation gun. The tow depth will be about 3 ft.

The receivers will be placed on a streamer that is towed behind the source vessel. The streamer will be about 984 ft in length and will contain 48 receivers at about 20 ft spacing.

Seismic data will be acquired on two grids. Grid 1 will contain lines spaced at 492 ft with perpendicular 984 ft spaced lines. Grid 2 will contain approximately 65 ft spaced lines. The total line length of both grids will be about 342 miles.

The vessel will travel with a speed of approximately 3–4 knots. The seismic pulse interval is 20.5 ft, which means a shot every 3 to 4 seconds.

TABLE 1—PROPOSED 30 IN³ AIRGUN ARRAY CONFIGURATIONS AND SOURCE SIGNATURES AS PREDICTED BY THE GUNDALF AIRGUN ARRAY MODEL FOR 1 M DEPTH

Array specifics	30 in³ Array option 1	30 in³ Array option 2
Number of guns	Three 2000 psi sleeve airguns (3 x 10 in³)	Two 2000 psi sleeve airguns (1 x 20 in³, 1 x 10 in³).
Zero to peak	4.89 bar-m (~234 dB re μPa @1 m)	3.62 bar-m (~231 dB re 1 μPa @1 m).
Peak to peak	9.75 bar-m (~240 dB re μPa @1 m)	7.04 bar-m (~237 dB re 1 μPa @1 m).
RMS pressure	0.28 bar-m (~209 dB re μPa @1 m)	0.22 bar-m (~207 dB re 1 μPa @1 m).
Dominant frequencies	About 20–300 Hz	About 20–300 Hz.

Multibeam Echosounder and Sidescan Sonar: A multibeam echosounder and sidescan sonar will be used to obtain high accuracy information regarding bathymetry and isonification of the seafloor. For accurate object detection, a side scan sonar survey is required to complement a multibeam echosounder survey.

The proposed multibeam echosounder operates at a root mean squared (rms) source level of approximately 220 dB re 1 μPa at 1 m. The multibeam echosounder emits high frequency energy in a fan-shaped pattern of equidistant or equiangular beam spacing. The beam width of the emitted sound energy in the along track direction is 2 degrees at 200 kilohertz (kHz) and 1 degree at 400 kHz, while the across track beam width is 1 degree at 200 kHz and 0.5 degrees at 400 kHz (see Table 2 in BP's application and this document). The maximum ping rate of the multibeam echosounder is 60 Hz.

The proposed sidescan sonar system will operate at about 100 kHz (120 kHz to 135 kHz) and 400 kHz (400 kHz to 450 kHz). The estimated rms source level is approximately 215 dB re 1 μPa at 1 m (Table 2). The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beam width of 1.5 degrees for 100 kHz and 0.4 degrees at 400 kHz, with a vertical beam height of 50 degrees. The maximum ping rate of the sidescan sonar is 30 Hz.

Data acquisition with the multibeam echosounder and sidescan sonar data will take place along all grids in the Sonar Survey area. Additional multibeam echosounder and sidescan sonar infill lines will be added to obtain 150% coverage over certain areas.

In addition, BP may conduct a strudel scour survey in the Kadleroshilik and Sagavanirktok River overflood areas for about 3 days, depending on results from reconnaissance flights in June. This data would be collected from a separate vessel equipped with a multibeam echosounder and sidescan sonar. These units would operate at a frequency of about 400 kHz. Because this operating frequency is outside the hearing range of marine mammals, the strudel scour survey is not part of BP's IHA application and is not analyzed further.

Subbottom Profiler: The purpose of the subbottom profiler is to provide an accurate digital image of the shallow sub-surface sea bottom, below the mud line. The proposed system emits energy in the frequency bands of 2 to 16 kHz (Table 2). The beam width is 15 to 24 degrees, depending on the center frequency. Typical pulse rate is between 3 and 6 Hz. Subbottom profiler data will be acquired continuously along all grids during Phase 2 of the operations (i.e., after 2DHR seismic data has been obtained).

Magnetometer: A marine magnetometer will be used for the detection of magnetic deflection generated by geologic features, and buried or exposed ferrous objects, which may be related to archaeological artifacts or modern man-made debris. The magnetometer will be towed at a sufficient distance behind the vessel to avoid data pollution by the vessel's magnetic properties. Magnetometers measure changes in magnetic fields over the seabed and do not produce sounds. Therefore, this piece of equipment is not anticipated to result in the take of marine mammals and is not analyzed further in this document.

TABLE 2—SOURCE CHARACTERISTICS OF THE PROPOSED GEOPHYSICAL SURVEY EQUIPMENT OF THE LIBERTY GEOHAZARD SURVEY

Equipment	Operating frequency	Along track beam width	Across track beam width	RMS sound pressure level
Multibeam echosounder	200–400 kHz	1–2°	0.5–1°	~220 dB re 1 μPa @1m.
Sidescan sonar	120–135 kHz	1.5°	50°	~215 dB re 1 μPa @1m.
	400–450 kHz	0.4°	50°	
Subbottom profiler	2–16 kHz	15–24°	15–24°	~216 dB re 1 μPa @1m.

Description of Marine Mammals in the Area of the Specified Activity

The Beaufort Sea supports a diverse assemblage of marine mammals. Table 3 lists the 12 marine mammal species under NMFS jurisdiction with confirmed or possible occurrence in the proposed project area.

TABLE 3—MARINE MAMMAL SPECIES WITH CONFIRMED OR POSSIBLE OCCURRENCE IN THE PROPOSED SEISMIC SURVEY AREA

Common name	Scientific name	Status	Occurrence	Seasonality	Range	Abundance
Odontocetes						
Beluga whale (Beaufort Sea stock).	*Delphinapterus leucas.*		Common	Mostly spring and fall with some in summer.	Russia to Canada	39,258

TABLE 3—MARINE MAMMAL SPECIES WITH CONFIRMED OR POSSIBLE OCCURRENCE IN THE PROPOSED SEISMIC SURVEY AREA—Continued

Common name	Scientific name	Status	Occurrence	Seasonality	Range	Abundance
Killer whale	*Orcinus orca*		Occasional/Extralimital.	Mostly summer and early fall.	California to Alaska.	552
Harbor porpoise	*Phocoena phocoena*.		Occasional/Extralimital.	Mostly summer and early fall.	California to Alaska.	48,215
Narwhal	*Monodon monoceros*.					45,358
Mysticetes Bowhead whale	*Balaena mysticetus*.	Endangered; Depleted.	Common	Mostly spring and fall with some in summer.	Russia to Canada	16,892
Gray whale	*Eschrichtius robustus*.		Somewhat common.	Mostly summer	Mexico to the U.S. Arctic Ocean.	19,126
Minke whale	*Balaenoptera acutorostrata*.					810–1,003
Humpback whale (Central North Pacific stock).	*Megaptera novaeangliae*.	Endangered; Depleted.				21,063
Pinnipeds Bearded seal (Beringia distinct population segment).	*Erigathus barbatus*.	Threatened; Depleted.	Common	Spring and summer.	Bering, Chukchi, and Beaufort Seas.	155,000
Ringed seal (Arctic stock).	*Phoca hispida*	Threatened; Depleted.	Common	Year round	Bering, Chukchi, and Beaufort Seas.	300,000
Spotted seal	*Phoca largha*		Common	Summer	Japan to U.S. Arctic Ocean.	141,479
Ribbon seal	*Histriophoca fasciata*.	Species of concern.	Occasional	Summer	Russia to U.S. Arctic Ocean.	49,000

Endangered, threatened, or species of concern under the Endangered Species Act (ESA); Depleted under the MMPA.

The highlighted (grayed out) species in Table 3 are so rarely sighted in the central Alaskan Beaufort Sea that their presence in the proposed project area, and therefore take, is unlikely. Minke whales are relatively common in the Bering and southern Chukchi seas and have recently also been sighted in the northeastern Chukchi Sea (Aerts *et al.,* 2013; Clarke *et al.,* 2013). Minke whales are rare in the Beaufort Sea. They have not been reported in the Beaufort Sea during the Bowhead Whale Aerial Survey Project/Aerial Surveys of Arctic Marine Mammals (BWASP/ASAMM) surveys (Clarke *et al.,* 2011, 2012; 2013; Monnet and Treacy, 2005), and there was only one observation in 2007 during vessel-based surveys in the region (Funk *et al.,* 2010). Humpback whales have not generally been found in the Arctic Ocean. However, subsistence hunters have spotted humpback whales in low numbers around Barrow, and there have been several confirmed sightings of humpback whales in the northeastern Chukchi Sea in recent years (Aerts *et al.,* 2013; Clarke *et al.,* 2013). The first confirmed sighting of a humpback whale in the Beaufort Sea was recorded in August 2007 (Hashagen *et al.,* 2009) when a cow and calf were observed 54 mi east of Point Barrow. No additional sightings have been documented in the Beaufort Sea. Narwhal are common in the waters of northern Canada, west Greenland, and in the European Arctic, but rarely occur in the Beaufort Sea (COSEWIC, 2004). Only a handful of sightings have occurred in Alaskan waters (Allen and Angliss, 2013). These three species are not considered further in this proposed IHA notice. Both the walrus and the polar bear could occur in the U.S. Beaufort Sea; however, these species are managed by the U.S. Fish and Wildlife Service (USFWS) and are not considered further in this Notice of Proposed IHA.

The Beaufort Sea is a main corridor of the bowhead whale migration route. The main migration periods occur in spring from April to June and in fall from late August/early September through October to early November. During the fall migration, several locations in the U.S. Beaufort Sea serve as feeding grounds for bowhead whales. Small numbers of bowhead whales that remain in the U.S. Arctic Ocean during summer also feed in these areas. The U.S. Beaufort Sea is not a main feeding or calving area for any other cetacean species. Ringed seals breed and pup in the Beaufort Sea; however, this does not occur during the summer or early fall. Further information on the biology and local distribution of these species can be found in BP's application (see **ADDRESSES**) and the NMFS Marine Mammal Stock Assessment Reports, which are available online at: *http://www.nmfs.noaa.gov/pr/species/.*

Potential Effects of the Specified Activity on Marine Mammals

This section includes a summary and discussion of the ways that the types of stressors associated with the specified activity (e.g., seismic airgun, sidescan sonar, subbottom profiler, vessel movement) have been observed to or are thought to impact marine mammals. This section may include a discussion of known effects that do not rise to the level of an MMPA take (for example, with acoustics, we may include a discussion of studies that showed animals not reacting at all to sound or exhibiting barely measurable avoidance). The discussion may also include reactions that we consider to rise to the level of a take and those that we do not consider to rise to the level of a take. This section is intended as a background of potential effects and does not consider either the specific manner in which this activity will be carried out or the mitigation that will be implemented or how either of those will shape the anticipated impacts from this specific activity. The ''Estimated Take by Incidental Harassment'' section later in this document will include a quantitative analysis of the number of individuals that are expected to be taken by this activity. The ''Negligible Impact Analysis'' section will include the analysis of how this specific activity will impact marine mammals and will consider the content of this section, the ''Estimated Take by Incidental Harassment'' section, the ''Mitigation'' section, and the ''Anticipated Effects on Marine Mammal Habitat'' section to draw conclusions regarding the likely impacts of this activity on the reproductive success or survivorship of individuals and from that on the affected marine mammal populations or stocks.

Background on Sound

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or kilohertz (kHz), while sound level describes the sound's intensity and is measured in decibels (dB). Sound level increases or decreases exponentially with each dB of change. The logarithmic nature of the scale means that each 10-dB increase is a 10-fold increase in acoustic power (and a 20-dB increase is then a 100-fold increase in power). A 10-fold increase in acoustic power does not mean that the sound is perceived as being 10 times louder, however. Sound levels are compared to a reference sound pressure (micro-Pascal) to identify the medium. For air and water, these reference pressures are ''re: 20 μPa'' and ''re: 1 μPa,'' respectively. Root mean square (RMS) is the quadratic mean sound pressure over the duration of an impulse. RMS is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1975). RMS accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part, because behavioral effects, which often result from auditory cues, may be better expressed through averaged units rather than by peak pressures.

Acoustic Impacts

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall *et al.* (2007) designate ''functional hearing groups'' for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (13 species of mysticetes): Functional hearing is estimated to occur between approximately 7 Hz and 30 kHz;
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz;
- Phocid pinnipeds in Water: Functional hearing is estimated to occur between approximately 75 Hz and 100 kHz; and
- Otariid pinnipeds in Water: Functional hearing is estimated to occur between approximately 100 Hz and 40 kHz.

As mentioned previously in this document, nine marine mammal species (five cetaceans and four phocid pinnipeds) may occur in the proposed seismic survey area. Of the five cetacean species likely to occur in the proposed project area and for which take is requested, two are classified as low-frequency cetaceans (i.e., bowhead and gray whales), two are classified as mid-frequency cetaceans (i.e., beluga and killer whales), and one is classified as a high-frequency cetacean (i.e., harbor porpoise) (Southall *et al.,* 2007). A species functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

1. Tolerance

Numerous studies have shown that underwater sounds from industry activities are often readily detectable by marine mammals in the water at distances of many kilometers. Numerous studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response to industry activities of various types (Miller *et al.,* 2005; Bain and Williams, 2006). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to underwater sound such as airgun pulses or vessels under some conditions, at other times mammals of all three types have shown no overt reactions (e.g., Malme *et al.,* 1986; Richardson *et al.,* 1995; Madsen and Mohl, 2000; Croll *et al.,* 2001; Jacobs and Terhune, 2002; Madsen *et al.,* 2002; Miller *et al.,* 2005). 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. Weir 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). The airgun arrays used in the Weir (2008) study were much larger than the array proposed for use during this proposed survey (total discharge volume of 30 in^3). In general, pinnipeds and small odontocetes seem to be more tolerant of exposure to some types of underwater sound than are baleen whales. Richardson *et al.* (1995) found that vessel noise does not seem to strongly affect pinnipeds that are already in the water. Richardson *et al.* (1995) went on to explain that seals on haul-outs sometimes respond strongly to the presence of vessels and at other times appear to show considerable tolerance of vessels.

2. Masking

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

Masking occurs when anthropogenic sounds and signals (that the animal utilizes) overlap at both spectral and temporal scales. For the airgun sound generated from the proposed seismic survey, sound will consist of low frequency (under 500 Hz) pulses with extremely short durations (less than one second). Lower frequency man-made sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. There is little concern regarding masking near the sound source due to the brief duration of these pulses and relatively longer silence between airgun shots (approximately 3–4 seconds). However, at long distances (over tens of kilometers away), due to multipath propagation and reverberation, the durations of airgun pulses can be ''stretched'' to seconds with long decays (Madsen *et al.,* 2006), although the intensity of the sound is greatly reduced.

This could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (e.g., Clark *et al.,* 2009) and cause increased stress levels (e.g., Foote *et al.,* 2004; Holt *et al.,* 2009). Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior by shifting call frequencies, and/or increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio and Clark, 2010). The North Atlantic right whales exposed to high shipping noise increase call frequency (Parks *et al.,* 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *el al.,* 2000). 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), possibly because animals moved away from the sound source or ceased calling (Blackwell *et al.,* 2013). Additionally, beluga whales have been known to change their vocalizations in the presence of high background noise possibly to avoid masking calls (Au *et al.,* 1985; Lesage *et al.,* 1999; Scheifele *et al.,* 2005). 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.

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 sounds by improving the effective signal-to-noise ratio. In the cases of higher 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 sound 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.

3. Behavioral Disturbance

Marine mammals may behaviorally react when exposed to anthropogenic sound. These behavioral reactions are often shown as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification have the potential to be biologically significant if the change affects growth, survival, or reproduction. Examples of significant behavioral modifications include:

• Drastic change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);

- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography, current activity, reproductive state) and is also difficult to predict (Gordon *et al.,* 2004; Southall *et al.,* 2007; Ellison *et al.,* 2011).

Mysticetes: Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. 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 greater distances (Miller *et al.,* 2005). However, baleen whales exposed to strong noise pulses often react by deviating from their normal migration route (Richardson *et al.,* 1999). Migrating gray and bowhead whales were observed avoiding the sound source by displacing their migration route to varying degrees but within the natural boundaries of the migration corridors (Schick and Urban, 2000; Richardson *et al.,* 1999; Malme *et al.,* 1983). Baleen whale responses to pulsed sound however may depend on the type of activity in which the whales are engaged. Some evidence suggests that feeding bowhead whales may be more tolerant of underwater sound than migrating bowheads (Miller *et al.,* 2005; Lyons *et al.,* 2009; Christie *et al.,* 2010).

Results of studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 µPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 2.8–9 mi (4.5–14.5 km) from the source. For the much smaller airgun array used during BP's proposed survey (total discharge volume of 30 in^3), the distance to received levels in the 160 dB re 1 µPa rms range is estimated to be 1 mi (1.6 km). Baleen whales within those distances may show avoidance or other strong disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and recent studies have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1 µPa rms. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with avoidance occurring out to distances of 12.4–18.6 mi (20–30 km) from a medium-sized airgun source (Miller *et al.,* 1999; Richardson *et al.,* 1999). However, more recent research on bowhead whales (Miller *et al.,* 2005) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, bowheads typically begin to show avoidance reactions at a received level of about 160–170 dB re 1 µPa rms (Richardson et al., 1986; Ljungblad *et al.,* 1988; Miller *et al.,* 2005).

Malme *et al.* (1986, 1988) studied the responses of feeding eastern 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% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 µPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast and on observations of the distribution of feeding Western Pacific gray whales off Sakhalin Island, Russia, during a seismic survey (Yazvenko *et al.,* 2007).

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. While it is not certain whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years, certain species have continued to use areas ensonified by airguns and have continued to increase in number despite successive years of anthropogenic activity in the area. Gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and much ship traffic in that area for decades (Appendix A in Malme *et al.,* 1984). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987). Populations of both gray whales and bowhead whales grew substantially during this time. In any event, the proposed survey will occur in summer (July through late August) when most bowhead whales are commonly feeding in the Mackenzie River Delta, Canada.

Patenaude *et al.* (2002) reported fewer behavioral responses to aircraft overflights by bowhead compared to beluga whales. Behaviors classified as reactions consisted of short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming, and breaching. Most bowhead reaction resulted from exposure to helicopter activity and little response to fixed-wing aircraft was observed. Most reactions occurred when the helicopter was at altitudes ≤492 ft (150 m) and lateral distances ≤820 ft (250 m; Nowacek *et al.,* 2007).

During their study, Patenaude *et al.* (2002) observed one bowhead whale cow-calf pair during four passes totaling 2.8 hours of the helicopter and two pairs during Twin Otter overflights. All of the helicopter passes were at altitudes of 49–98 ft (15–30 m). The mother dove both times she was at the surface, and the calf dove once out of the four times it was at the surface. For the cow-calf pair sightings during Twin Otter overflights, the authors did not note any behaviors specific to those pairs. Rather, the reactions of the cow-calf pairs were lumped with the reactions of other groups that did not consist of calves.

Richardson *et al.* (1995) and Moore and Clarke (2002) reviewed a few studies that observed responses of gray whales to aircraft. Cow-calf pairs were quite sensitive to a turboprop survey flown at 1,000 ft (305 m) altitude on the Alaskan summering grounds. In that survey, adults were seen swimming over the calf, or the calf swam under the adult (Ljungblad *et al.,* 1983, cited in Richardson *et al.,* 1995 and Moore and Clarke, 2002). However, when the same aircraft circled for more than 10 minutes at 1,050 ft (320 m) altitude over a group of mating gray whales, no reactions were observed (Ljungblad *et al.,* 1987, cited in Moore and Clarke, 2002). Malme *et al.* (1984, cited in Richardson *et al.,* 1995 and Moore and Clarke, 2002) conducted playback experiments on migrating gray whales. They exposed the animals to underwater noise recorded from a Bell 212 helicopter (estimated altitude = 328 ft [100 m]), at an average of three simulated passes per minute. The authors observed that whales changed their swimming course and sometimes slowed down in response to the playback sound but proceeded to migrate past the transducer. Migrating gray whales did not react overtly to a Bell 212 helicopter at greater than 1,394 ft (425 m) altitude, occasionally reacted when the helicopter was at 1,000–1,198 ft (305–365 m), and usually reacted when it was below 825 ft (250 m; Southwest Research Associates, 1988, cited in

Richardson *et al.,* 1995 and Moore and Clarke, 2002). Reactions noted in that study included abrupt turns or dives or both. Green *et al.* (1992, cited in Richardson *et al.,* 1995) observed that migrating gray whales rarely exhibited noticeable reactions to a straight-line overflight by a Twin Otter at 197 ft (60 m) altitude.

Odontocetes: Few systematic data are available describing reactions of toothed whales to noise pulses. However, systematic work on sperm whales is underway (Tyack *et al.,* 2003), and 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). Miller *et al.* (2009) conducted at-sea experiments where reactions of sperm whales were monitored through the use of controlled sound exposure experiments from large airgun arrays consisting of 20-guns and 31-guns. Of 8 sperm whales observed, none changed their behavior when exposed to either a ramp-up at 4–8 mi (7–13 km) or full array exposures at 0.6–8 mi (1–13 km).

Seismic operators and marine mammal observers sometimes see dolphins and other small toothed whales near operating airgun arrays, but, in general, there seems to be a tendency for most delphinids to show some limited avoidance of seismic vessels operating large airgun systems. However, 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. Nonetheless, there have been indications that small toothed whales sometimes move away or maintain a somewhat greater distance from the vessel when a large array of airguns is operating than when it is silent (e.g., Goold, 1996a,b,c; Calambokidis and Osmek, 1998; Stone, 2003). The beluga may be a species that (at least in certain geographic areas) shows long-distance avoidance of seismic vessels. Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 10–20 km (6.2–12.4 mi) of an active seismic vessel. These results were consistent with the low number of beluga sightings reported by observers aboard the seismic vessel, suggesting that some belugas might have been avoiding the seismic operations at distances of 10–20 km (6.2–12.4 mi) (Miller *et al.,* 2005).

Captive bottlenose dolphins and (of more relevance in this project) beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.,* 2002, 2005). However, the animals tolerated high received levels of sound (pk-pk level >200 dB re 1 μPa) before exhibiting aversive behaviors.

Observers stationed on seismic vessels operating off the United Kingdom from 1997–2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone, 2003; Gordon *et al.,* 2004). Killer whales were found to be significantly farther from large airgun arrays during periods of shooting compared with periods of no shooting. The displacement of the median distance from the array was approximately 0.5 km (0.3 mi) or more. Killer whales also appear to be more tolerant of seismic shooting in deeper water.

Reactions of toothed whales 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 mysticetes. However, based on the limited existing evidence, belugas should not be grouped with delphinids in the ''less responsive'' category.

Patenaude *et al.* (2002) reported that beluga whales appeared to be more responsive to aircraft overflights than bowhead whales. Changes were observed in diving and respiration behavior, and some whales veered away when a helicopter passed at ≤820 ft (250 m) lateral distance at altitudes up to 492 ft (150 m). However, some belugas showed no reaction to the helicopter. Belugas appeared to show less response to fixed-wing aircraft than to helicopter overflights.

Pinnipeds: Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources proposed for use. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of Arctic ice seals exposed to seismic pulses (Harris *et al.,* 2001; Moulton and Lawson, 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes of 560 to 1,500 in^3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson, 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to a few hundreds of meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Mate and Harvey, 1987; Jefferson and Curry, 1994; Richardson *et al.,* 1995). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson *et al.,* 1998). Even if reactions of the species occurring in the present study area are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on pinniped individuals or populations.

Blackwell *et al.* (2004) observed 12 ringed seals during low-altitude overflights of a Bell 212 helicopter at Northstar in June and July 2000 (9 observations took place concurrent with pipe-driving activities). One seal showed no reaction to the aircraft while the remaining 11 (92%) reacted, either by looking at the helicopter (n = 10) or by departing from their basking site (n = 1). Blackwell *et al.* (2004) concluded that none of the reactions to helicopters were strong or long lasting, and that seals near Northstar in June and July 2000 probably had habituated to industrial sounds and visible activities that had occurred often during the preceding winter and spring. There have been few systematic studies of pinniped reactions to aircraft overflights, and most of the available data concern pinnipeds hauled out on land or ice rather than pinnipeds in the water (Richardson *et al.,* 1995; Born *et al.,* 1999).

4. Threshold Shift (Noise-Induced Loss of Hearing)

When animals exhibit reduced hearing sensitivity (i.e., sounds must be louder for an animal to detect them) following exposure to an intense sound or sound for long duration, it is referred to as a noise-induced threshold shift (TS). An animal can experience temporary threshold shift (TTS) or permanent threshold shift (PTS). TTS can last from minutes or hours to days (i.e., there is complete recovery), can occur in specific frequency ranges (i.e., an animal might only have a temporary loss of hearing sensitivity between the frequencies of 1 and 10 kHz), and can be of varying amounts (for example, an animal's hearing sensitivity might be reduced initially by only 6 dB or reduced by 30 dB). PTS is permanent, but some recovery is possible. PTS can also occur in a specific frequency range and amount as mentioned above for TTS.

The following physiological mechanisms are thought to play a role in inducing auditory TS: Effects to sensory hair cells in the inner ear that reduce their sensitivity, modification of the chemical environment within the sensory cells, residual muscular activity in the middle ear, displacement of certain inner ear membranes, increased blood flow, and post-stimulatory reduction in both efferent and sensory neural output (Southall *et al.,* 2007). The amplitude, duration, frequency, temporal pattern, and energy distribution of sound exposure all can affect the amount of associated TS and the frequency range in which it occurs. As amplitude and duration of sound exposure increase, so, generally, does the amount of TS, along with the recovery time. For intermittent sounds, less TS could occur than compared to a continuous exposure with the same energy (some recovery could occur between intermittent exposures depending on the duty cycle between sounds) (Kryter *et al.,* 1966; Ward, 1997). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, prolonged exposure to sounds strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter, 1985). Although in the case of the proposed shallow geohazard survey, animals are not expected to be exposed to sound levels for durations long enough to result in PTS.

PTS is considered auditory injury (Southall *et al.,* 2007). Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.,* 2007).

Although the published body of scientific literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a loud sound, only a few studies provide empirical information on the levels at which noise-induced loss in hearing sensitivity occurs in nonhuman animals. For marine mammals, published data are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise (Finneran *et al.,* 2000, 2002b, 2003, 2005a, 2007, 2010a, 2010b; Finneran and Schlundt, 2010; Lucke *et al.,* 2009; Mooney *et al.,* 2009a, 2009b; Popov *et al.,* 2011a, 2011b; Kastelein *et al.,* 2012a; Schlundt *et al.,* 2000; Nachtigall *et al.,* 2003, 2004). For pinnipeds in water, data are limited to measurements of TTS in harbor seals, an elephant seal, and California sea lions (Kastak *et al.,* 1999, 2005; Kastelein *et al.,* 2012b).

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (i.e., recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious (similar to those discussed in auditory masking, below). For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts. Also, depending on the degree and frequency range, the effects of PTS on an animal could range in severity, although it is considered generally more serious because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.,* 2007), so we can infer that strategies exist for coping with this condition to some degree, though likely not without cost.

Marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause more than slight TTS, and, given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur as a result of the proposed shallow geohazard survey.

5. Non-Auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds.

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky *et al.,* 2005; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: Behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical ''fight or flight'' response, which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with ''stress.'' These responses have a relatively short duration and may or may not have significant long-term effects on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier, 1995), altered metabolism (Elasser *et al.,* 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano *et al.,* 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called ''distress'' (sensu Seyle, 1950) or ''allostatic loading'' (sensu McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005; Reneerkens *et al.,* 2002; Thompson and Hamer, 2000). Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as ''distress'' upon exposure to anthropogenic sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (e.g., elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (i.e., goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

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

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 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. Additionally, no beaked whale species occur in the proposed project area.

In general, very little is known about the potential for strong, anthropogenic 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. There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns, which are not proposed for use during this program. In addition, marine mammals that show behavioral avoidance of industry activities, including bowheads, belugas, and some pinnipeds, are especially unlikely to incur non-auditory impairment or other physical effects.

6. Stranding and Mortality

Marine mammals close to underwater detonations of high explosive can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.,* 1993; Ketten, 1995). Airgun pulses are less energetic and their peak amplitudes have slower rise times. To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays. Additionally, BP's project will use a very small airgun array in shallow water. NMFS does not expect any marine mammals will incur serious injury or mortality in the shallow waters of Foggy Island Bay or strand as a result of the proposed shallow geohazard survey.

7. Potential Effects From Sonar Systems on Marine Mammals

The multibeam echosounder proposed for use during BP's survey does not produce frequencies within the hearing range of marine mammals. Exposure to sounds generated by this instrument, therefore, does not present a risk of potential physiological damage, hearing impairment, and/or behavioral responses.

The sidescan sonar does not produce frequencies within the hearing range of mysticetes and ice seals, but when operating at 110–135 kHz could be audible by mid- and high-frequency cetaceans, depending on the strength of the signal. However, when it operates at the much higher frequencies greater than 400 kHz, it is outside of the hearing range of all marine mammals. The signal from side scan sonars is narrow, typically in the form of a conical beam projected directly below the vessel. Based on previous measurements of a sidescan sonar working at similar frequencies in deeper water, distances to sound levels of 190 and 180 dB re 1 μPa (rms) were 22 and 47 m, respectively (Warner and McCrodan, 2011). It is unlikely that an animal would be exposed for an extended time to a signal strong enough for TTS or PTS to occur, unless the animal is present within the beam under the vessel and swimming with the same speed and direction. The distance at which beluga whales could react behaviorally to the sidescan sonar signal is about 200 m (Warner and McCrodan, 2011). However, the response, if it occurs at all, is expected to be short term. Masking is unlikely to occur due to the nature of the signal and because beluga whales and ice seals generally vocalize at frequencies lower than 100 kHz.

Subbottom profilers will be audible to all three hearing classes of marine mammals that occur in the project area. Based on previous measurements of various subbottom profilers, the rms sound pressure level does not reach 180 dB re 1 μPa (Funk *et al.,* 2008; Ireland *et al.,* 2009; Warner and McCrodan, 2011). Distances to sound levels that could result in mild behavioral responses, such as avoidance, ranged from 1 to 30 m. Masking is unlikely due to the low duty cycle, directionality, and brief period when an individual mammal is likely to be within the beam. Additionally, the higher frequencies of the instrument are unlikely to overlap with the lower frequency calls by mysticetes.

Some stranding events of mid-frequency cetaceans were attributed to the presence of sonar surveys in the area (e.g., Southall *et al.,* 2006). Recently, an independent scientific review panel concluded that the mass stranding of approximately 100 melon-headed whales in northwest Madagascar in 2008 was primarily triggered by a multibeam echosounder system (Southall *et al.,* 2013), acknowledging that it was difficult to find evidence showing a direct cause-effect relationships. The multibeam echosounder proposed in this survey will operate at much higher frequencies, outside the hearing range of any marine mammal. The sidescan sonar and subbottom profiler are much less powerful. Considering the acoustic specifics of these instruments, the shallow water environment, the unlikely presence of toothed whales in the area, and planned mitigation measures, no marine mammal stranding or mortality are expected.

Vessel Impacts

Vessel activity and noise associated with vessel activity will temporarily increase in the action area during BP's survey as a result of the operation of one vessel. To minimize the effects of the vessel and noise associated with vessel activity, BP will alter speed if a marine mammal gets too close to a vessel. In addition, the vessel will be operating at slow speed (3–4 knots) when conducting surveys. Marine mammal monitoring observers will alert the vessel captain as animals are detected to ensure safe and effective measures are applied to avoid coming into direct contact with marine mammals. Therefore, NMFS neither anticipates nor authorizes takes of marine mammals from ship strikes.

McCauley *et al.* (1996) reported several cases of humpback whales responding to vessels in Hervey Bay, Australia. Results indicated clear avoidance at received levels between 118 to 124 dB in three cases for which response and received levels were observed/measured.

Palka and Hammond (2001) analyzed line transect census data in which the orientation and distance off transect line were reported for large numbers of minke whales. The authors developed a method to account for effects of animal movement in response to sighting platforms. Minor changes in locomotion speed, direction, and/or diving profile were reported at ranges from 1,847 to 2,352 ft (563 to 717 m) at received levels of 110 to 120 dB.

Odontocetes, such as beluga whales, killer whales, and harbor porpoises, often show tolerance to vessel activity; however, they may react at long distances if they are confined by ice, shallow water, or were previously harassed by vessels (Richardson *et al.,* 1995). Beluga whale response to vessel noise varies greatly from tolerance to extreme sensitivity depending on the activity of the whale and previous experience with vessels (Richardson *et al.,* 1995). Reactions to vessels depends on whale activities and experience, habitat, boat type, and boat behavior (Richardson *et al.,* 1995) and may include behavioral responses, such as altered headings or avoidance (Blane and Jaakson, 1994; Erbe and Farmer, 2000); fast swimming; changes in vocalizations (Lesage *et al.,* 1999; Scheifele *et al.,* 2005); and changes in dive, surfacing, and respiration patterns.

There are few data published on pinniped responses to vessel activity, and most of the information is anecdotal (Richardson *et al.,* 1995). Generally, sea lions in water show tolerance to close and frequently approaching vessels and sometimes show interest in fishing vessels. They are less tolerant when hauled out on land; however, they rarely react unless the vessel approaches within 100–200 m (330–660 ft; reviewed in Richardson *et al.,* 1995).

The addition of one vessel and noise due to vessel operations associated with the survey is not expected to have effects that could cause significant or long-term consequences for individual marine mammals or their populations.

Anticipated Effects on Marine Mammal Habitat

The primary potential impacts to marine mammal habitat and other marine species are associated with elevated sound levels produced by airguns and other active acoustic sources. This section describes the potential impacts to marine mammal habitat from the specified activity. Because the marine mammals in the area feed on fish and/or invertebrates there is also information on the species typically preyed upon by the marine mammals in the area.

Common Marine Mammal Prey in the Project Area

All of the marine mammal species that may occur in the proposed project area prey on either marine fish or invertebrates. The ringed seal feeds on fish and a variety of benthic species, including crabs and shrimp. Bearded seals feed mainly on benthic organisms, primarily crabs, shrimp, and clams. Spotted seals feed on pelagic and demersal fish, as well as shrimp and cephalopods. They are known to feed on a variety of fish including herring, capelin, sand lance, Arctic cod, saffron cod, and sculpins. Ribbon seals feed primarily on pelagic fish and invertebrates, such as shrimp, crabs, squid, octopus, cod, sculpin, pollack, and capelin. Juveniles feed mostly on krill and shrimp.

Bowhead whales feed in the eastern Beaufort Sea during summer and early autumn but continue feeding to varying degrees while on their migration through the central and western Beaufort Sea in the late summer and fall (Richardson and Thomson [eds.], 2002). When feeding in relatively shallow areas, bowheads feed throughout the water column. However, feeding is concentrated at depths where zooplankton is concentrated (Wursig *et al.,* 1984, 1989; Richardson [ed.], 1987; Griffiths *et al.,* 2002). Lowry and Sheffield (2002) found that copepods and euphausiids were the most common prey found in stomach samples from bowhead whales harvested in the Kaktovik area from 1979 to 2000. Areas to the east of Barter Island (which is approximately 90 mi east of BP's proposed survey area) appear to be used regularly for feeding as bowhead whales migrate slowly westward across the Beaufort Sea (Thomson and Richardson, 1987; Richardson and Thomson [eds.], 2002).

Recent articles and reports have noted bowhead whales feeding in several areas of the U.S. Beaufort Sea. The Barrow area is commonly used as a feeding area during spring and fall, with a higher proportion of photographed individuals displaying evidence of feeding in fall rather than spring (Mocklin, 2009). A bowhead whale feeding ''hotspot'' (Okkonen *et al.,* 2011) commonly forms on the western Beaufort Sea shelf off Point Barrow in late summer and fall. Favorable conditions concentrate euphausiids and copepods, and bowhead whales congregate to exploit the dense prey (Ashjian *et al.,* 2010, Moore *et al.,* 2010; Okkonen *et al.,* 2011). Surveys have also noted bowhead whales feeding in the Camden Bay area during the fall (Koski and Miller, 2009; Quakenbush *et al.,* 2010).

The 2006–2008 BWASP Final Report (Clarke *et al.,* 2011a) and the 2009 BWASP Final Report (Clarke *et al.,* 2011b) note sightings of feeding bowhead whales in the Beaufort Sea during the fall season. During that 4 year period, the largest groups of feeding whales were sighted between Smith Bay and Point Barrow (hundreds of miles to the west of Prudhoe Bay), and none were sighted feeding in Camden Bay (Clarke *et al.,* 2011a,b). Clarke and Ferguson (undated) examined the raw BWASP data from the years 2000–2009. They noted that feeding behavior was noted more often in September than October and that while bowheads were observed feeding throughout the study area (which includes the entire U.S. Beaufort Sea), sightings were less frequent in the central Alaskan Beaufort than they were east of Kaktovik and west of Smith Bay. Additionally, Clarke and Ferguson (undated) and Clarke *et al.* (2011b) refer to information from Ashjian *et al.* (2010), which describes the importance of wind-driven currents that produce favorable feeding conditions for bowhead whales in the area between Smith Bay and Point Barrow. Increased winds in that area may be increasing the incidence of upwelling, which in turn may be the reason for increased sightings of feeding bowheads in the area. Clarke and Ferguson (undated) also note that the incidence of feeding bowheads in the eastern Alaskan Beaufort Sea has decreased since the early 1980s.

Beluga whales feed on a variety of fish, shrimp, squid and octopus (Burns and Seaman, 1985). Very few beluga whales occur nearshore; their main migration route is much further offshore. Like several of the other species in the area, harbor porpoise feed on demersal and benthic species, mainly schooling fish and cephalopods. Depending on the type of killer whale (transient or resident), they feed on fish and/or marine mammals. However, harbor porpoises and killer whales are not commonly found in Foggy Island Bay.

Gray whales are primarily bottom feeders, and benthic amphipods and isopods form the majority of their summer diet, at least in the main summering areas west of Alaska (Oliver *et al.,* 1983; Oliver and Slattery, 1985). Farther south, gray whales have also been observed feeding around kelp beds, presumably on mysid crustaceans, and on pelagic prey such as small schooling fish and crab larvae (Hatler and Darling, 1974). However, the central Beaufort Sea is not known to be a primary feeding ground for gray whales.

Two kinds of fish inhabit marine waters in the study area: (1) True marine fish that spend all of their lives in salt water, and (2) anadromous species that reproduce in fresh water and spend parts of their life cycles in salt water.

Most arctic marine fish species are small, benthic forms that do not feed high in the water column. The majority of these species are circumpolar and are found in habitats ranging from deep offshore water to water as shallow as 16.4–33 ft (5–10 m; Fechhelm *et al.,* 1995). The most important pelagic species, and the only abundant pelagic species, is the Arctic cod. The Arctic cod is a major vector for the transfer of energy from lower to higher trophic levels (Bradstreet *et al.,* 1986). In summer, Arctic cod can form very large schools in both nearshore and offshore waters (Craig *et al.,* 1982; Bradstreet *et al.,* 1986). Locations and areas frequented by large schools of Arctic cod cannot be predicted but can be almost anywhere. The Arctic cod is a major food source for beluga whales, ringed seals, and numerous species of seabirds (Frost and Lowry, 1984; Bradstreet *et al.,* 1986).

Anadromous Dolly Varden char and some species of whitefish winter in rivers and lakes, migrate to the sea in spring and summer, and return to fresh water in autumn. Anadromous fish form the basis of subsistence, commercial, and small regional sport fisheries. Dolly Varden char migrate to the sea from May through mid-June (Johnson, 1980) and spend about 1.5–2.5 months there (Craig, 1989). They return to rivers beginning in late July or early August with the peak return migration occurring between mid-August and early September (Johnson, 1980). At sea, most anadromous corregonids (whitefish) remain in nearshore waters within several kilometers of shore (Craig, 1984, 1989). They are often termed ''amphidromous'' fish in that they make repeated annual migrations into marine waters to feed, returning each fall to overwinter in fresh water.

Benthic organisms are defined as bottom dwelling creatures. Infaunal organisms are benthic organisms that live within the substrate and are often sedentary or sessile (bivalves, polychaetes). Epibenthic organisms live on or near the bottom surface sediments and are mobile (amphipods, isopods, mysids, and some polychaetes). Epifauna, which live attached to hard substrates, are rare in the Beaufort Sea because hard substrates are scarce there. A small community of epifauna, the Boulder Patch, occurs in Stefansson Sound.

Many of the nearshore benthic marine invertebrates of the Arctic are circumpolar and are found over a wide range of water depths (Carey *et al.,* 1975). Species identified include polychaetes (*Spio filicornis, Chaetozone setosa, Eteone longa*), bivalves (*Cryrtodaria kurriana, Nucula tenuis, Liocyma fluctuosa*), an isopod (*Saduria entomon*), and amphipods (*Pontoporeia femorata, P. affinis*).

Nearshore benthic fauna have been studied in Beaufort Sea lagoons and near the mouth of the Colville River (Kinney *et al.,* 1971, 1972; Crane and Cooney, 1975). The waters of Simpson Lagoon, Harrison Bay, and the nearshore region support a number of infaunal species including crustaceans, mollusks, and polychaetes. In areas influenced by river discharge, seasonal changes in salinity can greatly influence the distribution and abundance of benthic organisms. Large fluctuations in salinity and temperature that occur over a very short time period, or on a seasonal basis, allow only very adaptable, opportunistic species to survive (Alexander *et al.,* 1974). Since shorefast ice is present for many months, the distribution and abundance of most species depends on annual (or more frequent) recolonization from deeper offshore waters (Woodward Clyde Consultants, 1995). Due to ice scouring, particularly in water depths of less than 8 ft (2.4 m), infaunal communities tend to be patchily distributed. Diversity increases with water depth until the shear zone is reached at 49–82 ft (15–25 m; Carey, 1978). Biodiversity then declines due to ice gouging between the landfast ice and the polar pack ice (Woodward Clyde Consultants, 1995).

Potential Impacts From Sound Generation

With regard to fish as a prey source for odontocetes and seals, fish are known to hear and react to sounds and to use sound to communicate (Tavolga *et al.,* 1981) and possibly avoid predators (Wilson and Dill, 2002). Experiments have shown that fish can sense both the strength and direction of sound (Hawkins, 1981). Primary factors determining whether a fish can sense a sound signal, and potentially react to it, are the frequency of the signal and the strength of the signal in relation to the natural background noise level.

Fishes produce sounds that are associated with behaviors that include territoriality, mate search, courtship, and aggression. It has also been speculated that sound production may provide the means for long distance communication and communication under poor underwater visibility conditions (Zelick *et al.,* 1999), although the fact that fish communicate at low-frequency sound levels where the masking effects of ambient noise are naturally highest suggests that very long distance communication would rarely be possible. Fishes have evolved a diversity of sound generating organs and acoustic signals of various temporal and spectral contents. Fish sounds vary in structure, depending on the mechanism used to produce them (Hawkins, 1993). Generally, fish sounds are predominantly composed of low frequencies (less than 3 kHz).

Since objects in the water scatter sound, fish are able to detect these objects through monitoring the ambient noise. Therefore, fish are probably able to detect prey, predators, conspecifics, and physical features by listening to environmental sounds (Hawkins, 1981). There are two sensory systems that enable fish to monitor the vibration-based information of their surroundings. The two sensory systems, the inner ear and the lateral line, constitute the acoustico-lateralis system.

Although the hearing sensitivities of very few fish species have been studied to date, it is becoming obvious that the intra- and inter-specific variability is considerable (Coombs, 1981). Nedwell *et al.* (2004) compiled and published available fish audiogram information. A noninvasive electrophysiological recording method known as auditory brainstem response is now commonly used in the production of fish audiograms (Yan, 2004). Generally, most fish have their best hearing in the low-frequency range (i.e., less than 1 kHz). Even though some fish are able to detect sounds in the ultrasonic frequency range, the thresholds at these higher frequencies tend to be considerably higher than those at the lower end of the auditory frequency range.

Literature relating to the impacts of sound on marine fish species can be divided into the following categories: (1) Pathological effects; (2) physiological effects; and (3) behavioral effects. Pathological effects include lethal and sub-lethal physical damage to fish; physiological effects include primary and secondary stress responses; and behavioral effects include changes in exhibited behaviors of fish. Behavioral changes might be a direct reaction to a detected sound or a result of the anthropogenic sound masking natural sounds that the fish normally detect and to which they respond. The three types of effects are often interrelated in complex ways. For example, some physiological and behavioral effects could potentially lead to the ultimate pathological effect of mortality. Hastings and Popper (2005) reviewed what is known about the effects of sound on fishes and identified studies needed to address areas of uncertainty relative to measurement of sound and the responses of fishes. Popper *et al.* (2003/2004) also published a paper that reviews the effects of anthropogenic sound on the behavior and physiology of fishes.

Potential effects of exposure to sound on marine fish include TTS, physical damage to the ear region, physiological stress responses, and behavioral responses such as startle response, alarm response, avoidance, and perhaps lack of response due to masking of acoustic cues. Most of these effects appear to be either temporary or intermittent and therefore probably do not significantly impact the fish at a population level. The studies that resulted in physical damage to the fish ears used noise exposure levels and durations that were far more extreme than would be encountered under conditions similar to those expected during BP's proposed survey.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona, 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas *et al.,* 1993).

Investigations of fish behavior in relation to vessel noise (Olsen *et al.,* 1983; Ona, 1988; Ona and Godo, 1990) have shown that fish react when the sound from the engines and propeller exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels are 110 dB to 130 dB (Nakken, 1992; Olsen, 1979; Ona and Godo, 1990; Ona and Toresen, 1988). However, other researchers have found that fish such as polar cod, herring, and capeline are often attracted to vessels (apparently by the noise) and swim toward the vessel (Rostad *et al.,* 2006). Typical sound source levels of vessel noise in the audible range for fish are 150 dB to 170 dB (Richardson *et al.,* 1995a). In calm weather, ambient noise levels in audible parts of the spectrum lie between 60 dB to 100 dB.

Short, sharp sounds can cause overt or subtle changes in fish behavior. Chapman and Hawkins (1969) tested the reactions of whiting (hake) in the field to an airgun. When the airgun was fired, the fish dove from 82 to 180 ft (25 to 55 m) depth and formed a compact layer. The whiting dove when received sound levels were higher than 178 dB re 1 μPa (Pearson *et al.,* 1992).

Pearson *et al.* (1992) conducted a controlled experiment to determine effects of strong noise pulses on several species of rockfish off the California coast. They used an airgun with a source level of 223 dB re 1 μPa. They noted:

- Startle responses at received levels of 200–205 dB re 1 μPa and above for two sensitive species, but not for two other species exposed to levels up to 207 dB;
- Alarm responses at 177–180 dB for the two sensitive species, and at 186 to 199 dB for other species;
- An overall threshold for the above behavioral response at about 180 dB;
- An extrapolated threshold of about 161 dB for subtle changes in the behavior of rockfish; and
- A return to pre-exposure behaviors within the 20–60 minute exposure period.

In summary, fish often react to sounds, especially strong and/or intermittent sounds of low frequency. Sound pulses at received levels of 160 dB re 1 μPa may cause subtle changes in behavior. Pulses at levels of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins, 1969; Pearson *et al.,* 1992; Skalski *et al.,* 1992). It also appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour. However, the habituation does not endure, and resumption of the strong sound source may again elicit disturbance responses from the same fish.

Some of the fish species found in the Arctic are prey sources for odontocetes and pinnipeds. A reaction by fish to sounds produced by BP's proposed survey would only be relevant to marine mammals if it caused concentrations of fish to vacate the area. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the sound source, if any would occur at all. Impacts on fish behavior are predicted to be inconsequential. Thus, feeding odontocetes and pinnipeds would not be adversely affected by this minimal loss or scattering, if any, of reduced prey abundance.

Some mysticetes, including bowhead whales, feed on concentrations of zooplankton. Some feeding bowhead whales may occur in the Alaskan Beaufort Sea in July and August, but feeding bowheads are more likely to occur in the area after the cessation of BP's survey operations. Reactions of zooplankton to sound are, for the most part, not known. Their ability to move significant distances is limited or nil, depending on the type of zooplankton. Behavior of zooplankters is not expected to be affected by the survey. These animals have exoskeletons and no air bladders. Many crustaceans can make sounds, and some crustacea and other invertebrates have some type of sound receptor. A reaction by zooplankton to sounds produced by the seismic survey would only be relevant to whales if it caused concentrations of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the sound source, if any would occur at all. Impacts on zooplankton behavior are predicted to be inconsequential. Thus, feeding mysticetes would not be adversely affected by this minimal loss or scattering, if any, of reduced zooplankton abundance.

Based on the preceding discussion, the proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations.

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 on the availability of such species or stock for taking for certain subsistence uses (where relevant). Later in this document in the ''Proposed Incidental Harassment Authorization'' section, NMFS lays out the proposed conditions for review, as they would appear in the final IHA (if issued).

Mitigation Measures Proposed by BP

For the proposed mitigation measures, BP proposed general mitigation measures that apply throughout the survey and specific mitigation measures that apply to airgun operations. The proposed protocols are discussed next and can also be found in Section 11 of BP's application (see **ADDRESSES**).

1. General Mitigation Measures

These general mitigation measures are proposed to apply at all times to the vessel involved in the Liberty geohazard survey. This vessel would also operate under an additional set of specific mitigation measures during airgun operations (described a bit later in this document).

The general mitigation measures include: (1) Adjusting speed to avoid collisions with whales and during periods of low visibility; (2) checking the waters immediately adjacent to the vessel to ensure that no marine mammals will be injured when the vessel's propellers (or screws) are engaged; (3) avoiding concentrations of groups of whales and not operating vessels in a way that separates members of a group; (4) reducing vessel speeds to less than 10 knots in the presence of feeding whales; (5) reducing speed and steering around groups of whales if circumstances allow (but never cutting off a whale's travel path) and avoiding multiple changes in direction and speed when within 900 ft of whales; (6) maintaining an altitude of at least 1,000 ft when flying helicopters, except in emergency situations or during take-offs and landings; and (7) not hovering or circling with helicopters above or within 0.3 mi of groups of whales.

2. Seismic Airgun Mitigation Measures

BP proposes to establish and monitor Level A harassment exclusion zones for all marine mammal species. These zones will be monitored by Protected Species Observers (PSOs; more detail later). Should marine mammals enter these exclusion zones, the PSOs will call for and implement the Suite of mitigation measures described next.

Ramp-up Procedure: Ramp-up procedures of an airgun array involve a step-wise increase in the number of operating airguns until the required discharge volume is achieved. The purpose of a ramp-up (sometimes referred to as ''soft-start'') is to provide marine mammals in the vicinity of the activity the opportunity to leave the area and to avoid the potential for injury or impairment of their hearing abilities.

During ramp-up, BP proposes to implement the common procedure of doubling the number of operating airguns at 5-minute intervals, starting with the smallest gun in the array. Ramp-up of the 30 in^3 array from a shutdown will therefore take 10 min for the three-airgun array option and 5 min for the two-airgun array option. First the smallest gun in the array will be activated (10 in^3) and after 5 min, the second airgun (10 in^3 or 20 in^3). For the three-airgun array, an additional 5 min are then required to activate the third 10 in^3 airgun. During ramp-up, the exclusion zone for the full airgun array will be observed. The ramp-up procedures will be applied as follows:

1. A ramp-up, following a cold start, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp-up from a cold start cannot begin.

2. Ramp-up procedures from a cold start will be delayed if a marine mammal is sighted within the exclusion zone during the 30-minute period prior to the ramp-up. The delay will last until the marine mammal(s) has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 minutes (seals) or 30 minutes (cetaceans).

3. A ramp-up, following a shutdown, can be applied if the marine mammal(s) for which the shutdown occurred has been observed to leave the exclusion zone or until the animal(s) has not been sighted for at least 15 minutes (seals) or 30 minutes (cetaceans). This assumes there was a continuous observation effort prior to the shutdown and the entire exclusion zone is visible.

4. If, for any reason, power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures need to be implemented. Only if the PSO watch has been suspended, a 30-minute clearance of the

exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

5. The seismic operator and PSOs will maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

Power Down Procedure: A power down is the immediate reduction in the number of operating airguns such that the radii of the 190 dB and 180 dB (rms) zones are decreased to the extent that an observed marine mammal is not in the applicable exclusion zone of the full array. For this geohazard survey, the operation of one airgun continues during a power down. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of airgun activity, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.

1. The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single airgun;

2. Likewise, if a mammal is already within the exclusion zone of the full array when first detected, the airgun array will be powered down to one operating gun immediately;

3. If a marine mammal is sighted within or about to enter the applicable exclusion zone of the single airgun, it too will be shut down; and

4. Following a power down, ramp-up to the full airgun array will not resume until the marine mammal has cleared the applicable exclusion zone. The animal will be considered to have cleared the exclusion zone if it has been visually observed leaving the exclusion zone of the full array, or has not been seen within the zone for 15 minutes (seals) or 30 minutes (cetaceans).

Shut-down Procedures: The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the 190 or 180 dB (rms) exclusion radius of the smallest airgun. Airgun activity will not resume until the marine mammal has cleared the applicable exclusion radius of the full array. The animal will be considered to have cleared the exclusion radius as described above under ramp-up procedures.

Poor Visibility Conditions: BP plans to conduct 24-hr operations. PSOs will not be on duty during ongoing seismic operations during darkness, given the very limited effectiveness of visual observation at night (there will be no periods of darkness in the survey area until mid-August). The proposed provisions associated with operations at night or in periods of poor visibility include the following:

- If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down; and
- If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

BP is aware that available techniques to effectively detect marine mammals during limited visibility conditions (darkness, fog, snow, and rain) are in need of development and has in recent years supported research and field trials intended to improve methods of detecting marine mammals under these conditions.

Additional Mitigation Measures Proposed by NMFS

The mitigation airgun will be operated at approximately one shot per minute and will not be operated for longer than three hours in duration during daylight hours and good visibility. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, use of the mitigation airgun may be initiated 30 minutes before darkness or low visibility conditions occur and may be operated until the start of the next seismic acquisition line. The mitigation gun must still be operated at approximately one shot per minute.

Mitigation Conclusions

NMFS has carefully evaluated BP's proposed mitigation measures and 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:

- The manner in which, and the degree to which, the successful implementation of the measures are expected to minimize adverse impacts to marine mammals;
- The proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and
- The practicability of the measure for applicant implementation.

Any mitigation measure(s) prescribed by NMFS should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

1. Avoidance or minimization of injury or death of marine mammals wherever possible (goals 2, 3, and 4 may contribute to this goal).

2. A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to received levels of seismic airguns, or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

3. A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels of seismic airguns or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

4. A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels of seismic airguns or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing the severity of harassment takes only).

5. Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.

6. For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammals species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance. Proposed measures to ensure availability of such species or stock for taking for certain subsistence uses are discussed later in this document (see ''Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses'' section).

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 ITAs 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 proposed action area. BP submitted information regarding marine mammal monitoring to be conducted during seismic operations as part of the IHA application. That information can be found in Sections 11 and 13 of the application. The monitoring measures may be modified or supplemented based on comments or new information received from the public during the public comment period.

Monitoring measures proposed by the applicant or prescribed by NMFS should accomplish one or more of the following top-level goals:

1. An increase in our understanding of the likely occurrence of marine mammal species in the vicinity of the action, i.e., presence, abundance, distribution, and/or density of species.

2. An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammal species to any of the potential stressor(s) associated with the action (e.g. sound or visual stimuli), through better understanding of one or more of the following: the action itself and its environment (e.g. sound source characterization, propagation, and ambient noise levels); the affected species (e.g. life history or dive pattern); the likely co-occurrence of marine mammal species with the action (in whole or part) associated with specific adverse effects; and/or the likely biological or behavioral context of exposure to the stressor for the marine mammal (e.g. age class of exposed animals or known pupping, calving or feeding areas).

3. An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).

4. An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: the long-term fitness and survival of an individual; or the population, species, or stock (e.g. through effects on annual rates of recruitment or survival).

5. An increase in our understanding of how the activity affects marine mammal habitat, such as through effects on prey sources or acoustic habitat (e.g., through characterization of longer-term contributions of multiple sound sources to rising ambient noise levels and assessment of the potential chronic effects on marine mammals).

6. An increase in understanding of the impacts of the activity on marine mammals in combination with the impacts of other anthropogenic activities or natural factors occurring in the region.

7. An increase in our understanding of the effectiveness of mitigation and monitoring measures.

8. An increase in the probability of detecting marine mammals (through improved technology or methodology), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.

Proposed Monitoring Measures

1. Visual Monitoring

Two observers referred to as PSOs will be present on the vessel. Of these two PSOs, one will be on watch at all times to monitor the 190 and 180 dB exclusion zones for the presence of marine mammals during airgun operations. The main objectives of the vessel-based marine mammal monitoring are as follows: (1) To implement mitigation measures during seismic operations (e.g. course alteration, airgun power down, shut-down and ramp-up); and (2) To record all marine mammal data needed to estimate the number of marine mammals potentially affected, which must be reported to NMFS within 90 days after the survey.

BP intends to work with experienced PSOs. At least one Alaska Native resident, who is knowledgeable about Arctic marine mammals and the subsistence hunt, is expected to be included as one of the team members aboard the vessel. Before the start of the survey, the vessel crew will be briefed on the function of the PSOs, their monitoring protocol, and mitigation measures to be implemented.

At least one observer will monitor for marine mammals at any time during daylight hours (there will be no periods of total darkness until mid-August). PSOs will be on duty in shifts of a maximum of 4 hours at a time, although the exact shift schedule will be established by the lead PSO in consultation with the other PSOs.

The vessel will offer a suitable platform for marine mammal observations. Observations will be made from locations where PSOs have the best view around the vessel. During daytime, the PSO(s) will scan the area around the vessel systematically with reticle binoculars and with the naked eye. Because the main purpose of the PSO on board the vessel is detecting marine mammals for the implementation of mitigation measures according to specific guidelines, BP prefers to keep the information to be recorded as concise as possible, allowing the PSO to focus on detecting marine mammals. The following information will be collected by the PSOs:

- Environmental conditions—consisting of sea state (in Beaufort Wind force scale according to NOAA), visibility (in km, with 10 km indicating the horizon on a clear day), and sun glare (position and severity). These will be recorded at the start of each shift, whenever there is an obvious change in one or more of the environmental variables, and whenever the observer changes shifts;
- Project activity—consisting of airgun operations (on or off), number of active guns, line number. This will be recorded at the start of each shift, whenever there is an obvious change in project activity, and whenever the observer changes shifts; and
- Sighting information—consisting of the species (if determinable), group size, position and heading relative to the vessel, behavior, movement, and distance relative to the vessel (initial and closest approach). These will be recorded upon sighting a marine mammal or group of animals.

When marine mammals in the water are detected within or about to enter the designated exclusion zones, the airgun(s) power down or shut-down procedures will be implemented immediately. To assure prompt implementation of power downs and shut-downs, multiple channels of communication between the PSOs and the airgun technicians will be established. During the power down and shut-down, the PSO(s) will continue to maintain watch to determine when the animal(s) are outside the exclusion radius. Airgun operations can be resumed with a ramp-up procedure (depending on the extent of the power down) if the observers have visually confirmed that the animal(s) moved outside the exclusion zone, or if the animal(s) were not observed within the exclusion zone for 15 minutes (seals) or for 30 minutes (cetaceans). Direct communication with the airgun operator will be maintained throughout these procedures.

All marine mammal observations and any airgun power down, shut-down, and ramp-up will be recorded in a standardized format. Data will be entered into or transferred to a custom database. The accuracy of the data entry will be verified daily through QA/QC procedures. Recording procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to other programs for further processing and archiving.

2. Fish and Airgun Sound Monitoring

BP proposes to conduct research on fish species in relation to airgun operations, including prey species important to ice seals, during the proposed seismic survey. The Liberty shallow geohazard survey, along with another seismic survey BP is conducting this summer in Prudhoe Bay, offers a unique opportunity to assess the impacts of airgun sounds on fish, specifically on changes in fish abundance in fyke nets that have been sampled in the area for more than 30 years. The monitoring study would occur over a 2-month period during the open-water season. During this time, fish are counted and sized every day, unless sampling is prevented by weather, the presence of bears, or other events. Fish mortality is also noted.

The fish-sampling period coincides with the shallow geohazard survey, resulting in a situation where each of the four fyke nets will be exposed to varying daily exposures to airgun sounds. That is, as source vessels move back and forth across the project area, fish caught in nets will be exposed to different sounds levels at different nets each day. To document relationships between fish catch in each fyke net and received sound levels, BP will attempt to instrument each fyke net location with a recording hydrophone. Recording hydrophones, to the extent possible, will have a dynamic range that extends low enough to record near ambient sounds and high enough to capture sound levels during relatively close approaches by the airgun array (i.e., likely levels as high as about 200 dB re 1 uPa). Bandwidth will extend from about 10 Hz to at least 500 Hz. In addition, because some fish (especially salmonids) are likely to be sensitive to particle velocity instead of or in addition to sound pressure level, BP will attempt to instrument each fyke net location with a recording particle velocity meter. Acoustic and environmental data will be used in statistical models to assess relationships between acoustic and fish variables. Additional information on the details of the fish monitoring study can be found in Section 13.1 of BP's application (see **ADDRESSES**).

Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS' implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR 216.108(d)).

Because of the extremely short duration of BP's proposed survey, the fact that activities will be completed prior to any fall bowhead whale subsistence hunts, and that seal hunts occur more than 50 mi from the proposed survey activities, NMFS determined that the proposed survey did not meet the trigger for requiring an independent peer review of the monitoring plan.

Reporting Measures

1. 90-Day Technical Report

A report will be submitted to NMFS within 90 days after the end of the proposed shallow geohazard survey. The report will summarize all activities and monitoring results conducted during in-water seismic surveys. The Technical Report will include the following:

- Summary of project start and end dates, airgun activity, number of guns, and the number and circumstances of implementing ramp-up, power down, shutdown, and other mitigation actions;
- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);
- Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), and group sizes;
- Analyses of the effects of survey operations;
- Sighting rates of marine mammals during periods with and without seismic survey activities (and other variables that could affect detectability), such as: (i) Initial sighting distances versus survey activity state; (ii) closest point of approach versus survey activity state; (iii) observed behaviors and types of movements versus survey activity state; (iv) numbers of sightings/individuals seen versus survey activity state; (v) distribution around the source vessels versus survey activity state; and (vi) estimates of exposures of marine mammals to Level B harassment thresholds based on presence in the 160 dB harassment zone.

2. Fish and Airgun Sound Report

BP proposes to present the results of the fish and airgun sound study to NMFS in a detailed report that will also be submitted to a peer reviewed journal for publication, presented at a scientific conference, and presented in Barrow and Nuiqsut.

3. Notification of Injured or Dead 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), BP 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, and the Alaska Regional Stranding Coordinators. The report would 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 hours 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 hours 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 BP to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. BP would not be able to resume their activities until notified by NMFS via letter, email, or telephone.

In the event that BP 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), BP would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators. The report would include the same information identified in the paragraph above. Activities would be able to continue while NMFS reviews the circumstances of the incident. NMFS would work with BP to determine whether modifications in the activities are appropriate.

In the event that BP 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), BP would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. BP would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

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 behavioral harassment of some species is anticipated as a result of the proposed shallow geohazard survey. Anticipated impacts to marine mammals are associated with noise propagation from the sound sources (e.g., airguns, sidescan sonar, and subbottom profiler) used in the survey. No take is expected to result from vessel strikes because of the slow speed of the vessel (3–4 knots while acquiring seismic data) and because of mitigation measures to reduce collisions with marine mammals. Additionally, no take is expected to result from helicopter operations (if any occur) because of altitude restrictions. No take is expected from the multibeam echosounder and when the sidescan sonar is operated at frequencies above 400 kHz because the frequencies are outside the hearing ranges of marine mammals. Moreover, when the sidescan sonar is operated at frequencies of 110–135 kHz, it is outside the hearing ranges of low-frequency cetaceans and ice seals. Therefore, take has not been estimated from use of these sources for these species.

BP requested take of 11 marine mammal species by Level B harassment. However, for reasons mentioned earlier in this document, it is highly unlikely that humpback and minke whales would occur in the proposed survey area. Therefore, NMFS does not propose to authorize take of these two species. The species for which take, by Level B harassment only, is proposed include: bowhead, beluga, gray, and killer whales; harbor porpoise; and ringed, bearded, spotted, and ribbon seals.

The airguns produce impulsive sounds. The current acoustic thresholds used by NMFS to estimate Level B and Level A harassment are presented in Table 4.

TABLE 4—CURRENT ACOUSTIC EXPOSURE CRITERIA USED BY NMFS

Criterion	Criterion definition	Threshold
Level A Harassment (Injury)	Permanent Threshold Shift (PTS) (Any level above that which is known to cause TTS)	180 dB re 1 microPa-m (cetaceans)/190 dB re 1 microPa-m (pinnipeds) root mean square (rms).
Level B Harassment	Behavioral Disruption (for impulse noises)	160 dB re 1 microPa-m (rms).
Level B Harassment	Behavioral Disruption (for continuous, noise)	120 dB re 1 microPa-m (rms).

Section 6 of BP's application contains a description of the methodology used by BP to estimate takes by harassment, including calculations for the 160 dB (rms) isopleth and marine mammal densities in the areas of operation (see **ADDRESSES**), which is also provided in the following sections. NMFS verified BP's methods, and used the density and sound isopleth measurements in estimating take. However, as noted later in this section, NMFS proposes to authorize the maximum number of estimated takes for all species, not just for cetaceans as presented by BP in order to ensure that exposure estimates are not underestimated for pinnipeds.

The shallow geohazard survey will take place in two phases and has an estimated duration of approximately 20 days, including 5 days between the two phases where operations will be focused on changing equipment. Data acquisition will be halted at the start of the Cross Island fall bowhead whale hunt.

During phase 1 of the project, 2DHR seismic data will be acquired in about 12 mi^2 of the Site Survey area. The duration is estimated at about 7.5 days, based on a continuous 24-hr operation and not including downtime.

During phase 2, data will be acquired in the Site Survey area (11 mi^2) and over approximately 5 mi^2 of the 29 mi^2 Sonar Survey area using the multibeam echosounder, sidescan sonar, subbottom profiler, and magnetometer. The total duration of Phase 2 is also expected to be 7.5 days, based on a continuous 24-hr operation and not including downtime.

Marine Mammal Density Estimates

Most whale species are migratory and therefore show a seasonal distribution, with different densities for the summer period (covering July and August) and the fall period (covering September and October). Seal species in the Beaufort Sea do not show a distinct seasonal distribution during the open-water period between July and October. Data acquisition of the proposed shallow geohazard survey will only take place in summer (before start of Nuiqsut whaling in late August/early September), so BP estimated only summer densities for this proposed IHA. Whale and seal densities in the Beaufort Sea will further depend on the presence of sea ice. However, if ice cover within or close to the seismic survey area is more than approximately 10%, survey activities may not start or will be halted. Densities related to ice conditions are therefore not included in the IHA application.

Spatial differentiation is another important factor for marine mammal densities, both in latitudinal and longitudinal gradient. Taking into account the shallow water operations of the proposed survey area and the associated area of influence, BP used data from the nearshore zone of the Beaufort Sea for the calculation of densities, if available.

Density estimates are based on best available data. Because available data did not always cover the area of interest, this is subject to large temporal and spatial variation, and correction factors for perception and availability bias were not always known, there is some uncertainty in the data and assumptions used in the estimated number of exposures. To provide allowance for these uncertainties, maximum density estimates have been provided in addition to average density estimates.

1. Beluga Whale Density Estimates

The 1979–2011 BWASP aerial survey database, available from the NOAA Web site (*http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php*), contains a total of 62 belugas (31 sightings) in block 1, which covers the nearshore and offshore Prudhoe Bay area. Except for one solitary animal in 1992, all these belugas were seen in September or October; the months with most aerial survey effort. None of the sightings occurred south of 70° N., which is to be expected because beluga whales generally travel much farther north (Moore *et al.,* 2000). The summer effort in the 1979–2011 database is limited. Therefore, BP believes and NMFS agrees that the 2012–2013 data are the best available for calculating beluga summer densities (Clarke *et al.,* 2013; *http://www.asfc.noaa.gov/nmml/cetacean/bwasp/2013*), even though the 2013 daily flight summaries posted on NOAA's Web site have not undergone post-season QA/QC.

To estimate the density of beluga whales in the Foggy Island Bay area, BP used the 2012 on-transect beluga sighting and effort data from the ASAMM surveys flown in July and August in the Beaufort Sea. The area most applicable to our survey was the area from 140° W. − 154° W. and water depths of 0–20 m (Table 13 in Clarke *et al.,* 2013). In addition, BP used beluga sighting and effort data of the 2013 survey, as reported in the daily flight summaries on the NOAA Web site. BP intended to only select flights that covered block 1. However, in many cases the aerial surveys flown in block 1 also covered blocks 2 and 10, which were much farther from shore. Because it was difficult to determine the survey effort specific to block 1 from the available information, BP included the sighting and effort data from block 2 and 10 in the calculations. BP used the number of individuals counted on transect, together with the transect kilometers flown, to calculate density estimates (Table 4 in the application and Table 5 here). To convert the number of individuals per transect kilometer (ind/km) to a density per area (ind/km²), BP used the effective strip width (ESW) of 0.614 km for belugas calculated from 2008–2012 aerial survey data flown with the Commander aircraft (M. Ferguson, NMML, pers. comm., 30 Oct 2013).

TABLE 5—SUMMARY OF BELUGA SIGHTING AND EFFORT DATA FROM THE 2012 AND 2013 ASAMM AERIAL SURVEYS FLOWN IN JULY AND AUGUST IN THE BEAUFORT SEA

Year	Effort (ind/km)	NR. Ind	Ind/km	Ind/km²
2012	1431	5	0.0035	0.0028
2013	7572	99	0.0131	0.0182
Average				0.0105
Maximum				0.0182
Minimum				0.0028

2. Bowhead Whale Density Estimates

To estimate summer bowhead whale densities, BP used data from the 2012 and 2013 ASAMM aerial surveys flown in the Beaufort Sea (Clarke *et al.,* 2013; *www.asfc.noaa.gov/nmml/*). The 1979–2011 ASAMM database contains only one on-transect bowhead whale sighting during July and August (in 2011), likely due to the limited summer survey effort. In contrast, the 2012 and 2013 surveys include substantial effort during the summer season and are thus considered to be the best available data, even though the 2013 daily flight summaries posted on NOAA's Web site have not undergone post-season QA/QC.

To estimate the density of bowhead whales in the Foggy Island Bay area, BP used the 2012 on-transect bowhead sighting and effort data from surveys flown in July and August in block 1 (Table 4 in Clarke *et al.,* 2013). In addition, BP used the on-transect bowhead sighting and effort data of the 2013 survey, as reported in the daily flight summaries on the NOAA Web site. BP intended to only select flights that covered block 1. However, in many cases the aerial surveys flown in block 1 also covered blocks 2 and 10, which were much farther from shore. Because it was difficult to determine the survey effort specific to block 1 from the available information, BP included the sighting and effort data from block 2 and 10 in the calculations (Table 5 in the application and Table 6 here). To convert the number of individuals per line transect (ind/km) to a density per area (ind/km²), BP used the ESW of 1.15 km for bowheads, calculated from 2008–2012 aerial survey data flown with the Commander aircraft (M. Ferguson, NMML, pers. comm., 30 Oct 2013).

TABLE 6—SUMMARY OF BOWHEAD SIGHTING AND EFFORT DATA FROM THE 2012 AND 2013 ASAMM AERIAL SURVEYS FLOWN IN JULY AND AUGUST IN THE BEAUFORT SEA

Year	Effort (ind/km)	NR. ind	Ind/km	Ind/km²
2012	1493	5	0.0033	0.0015
2013	3973	88	0.0221	0.0096
Average				0.0055
Maximum				0.0096
Minimum				0.0015

3. Other Whale Species

No densities have been estimated for gray whales and for whale species that are rare or extralimital to the Beaufort Sea (killer whale and harbor porpoise) because sightings of these animals have been very infrequent. Gray whales may be encountered in small numbers throughout the summer and fall, especially in the nearshore areas. Small numbers of harbor porpoises may be encountered as well. During an aerial survey offshore of Oliktok Point in 2008, approximately 40 mi (65 km) west of the proposed survey area, two harbor porpoises were sighted offshore of the barrier islands, one on 25 August and the other on 10 September (Hauser *et al.,* 2008). For the purpose of this IHA request, small numbers have been included in the requested ‘‘take’’ authorization to cover incidental occurrences of any of these species during the proposed survey.

4. Seal Density Estimates

Ice seals of the Beaufort Sea are mostly associated with sea ice, and most census methods count seals when they are hauled out on the ice. To account for the proportion of animals present but not hauled out (availability bias) or seals present on the ice but missed (detection bias), a correction factor should be applied to the ‘‘raw’’ counts. This correction factor is dependent on the behavior of each species. To estimate what proportion of ringed seals were generally visible resting on the sea ice, radio tags were placed on seals during spring 1999–2003 (Kelly *et al.,* 2006). The probability that seals were visible, derived from the satellite data, was applied to seal abundance data from past aerial surveys and indicated that the proportion of seals visible varied from less than 0.4 to more than 0.75 between survey years. The environmental factors that are important in explaining the availability of seals to be counted were found to be time of day, date, wind speed, air temperature, and days from snow melt (Kelly *et al.,* 2006). Besides the uncertainty in the correction factor, using counts of basking seals from spring surveys to predict seal abundance in the open-water period is further complicated by the fact that seal movements differ substantially between these two seasons. Data from nine ringed seals that were tracked from one subnivean period (early winter through mid-May or early June) to the next showed that ringed seals covered large distances during the open-water foraging period (Kelly *et al.,* 2010b). Ringed seals tagged in 2011 close to Barrow also show long distances traveled during the open-water season (Herreman *et al.,* 2012).

To estimate densities for ringed, bearded, and spotted seals, BP used data collected during four shallow water OBC seismic surveys in the Beaufort Sea (Harris *et al.,* 2001; Aerts *et al.,* 2008; Hauser *et al.,* 2008; HDR, 2012). Habitat and survey specifics are very similar to the proposed survey; therefore, these data were considered to be more representative than basking seal densities from spring aerial survey data (e.g., Moulton *et al.,* 2002; Frost *et al.,* 2002, 2004). NMFS agreed that these data are likely more representative and appropriate for use. However, since these data were not collected during surveys designed to determine abundance, NMFS used the maximum estimates for the proposed number of takes in this proposed IHA.

Because survey effort in kilometers was only reported for one of the surveys, BP used sighting rate (ind/h) for calculating potential seal exposures. No distinction is made in seal density between summer and autumn season. Also, no correction factors have been applied to the reported seal sighting rates.

Seal species ratios: During the 1996 OBC survey, 92% of all seal species identified were ringed seals, 7% bearded seals and 1% spotted seals (Harris *et al.,* 2001). This 1996 survey occurred in two habitats, one about 19 mi east of Prudhoe Bay near the McClure Islands, mainly inshore of the barrier islands in water depths of 10 to 26 ft and the other 6 to 30 mi northwest of Prudhoe Bay, about 0 to 8 mile offshore of the barrier islands in water depths of 10 to 56 ft (Harris *et al.,* 2001). In 2008, two OBC seismic surveys occurred in the Beaufort Sea, one in Foggy Island Bay, about 15 mi SE of Prudhoe Bay (Aerts *et al.,* 2008), and the other at Oliktok Point, > 30 mi west of Prudhoe Bay (Hauser *et al.,* 2008). In 2012, an OBC seismic was done in Simpson Lagoon, bordering the area surveyed in 2008 at Oliktok Point (HDR, 2012). Based on the number of identified individuals the ratio ringed, bearded, and spotted seal was 75%, 8%, and 17%, respectively in Foggy Island Bay (Aerts *et al.,* 2008), 22%, 39%, and 39%, respectively at Oliktok Point (Hauser *et al.,* 2008), and 62%, 15%, and 23%, respectively in Simpson Lagoon (HDR, 2012). Because it is often difficult to identify seals to species, a large proportion of seal sightings were unidentified in all four OBC surveys described here. The total seal sighting rate was therefore used to calculate densities for each species, using the average ratio over all four surveys for ringed, bearded, and spotted seals, i.e., 63% ringed, 17% bearded, and 20% spotted seals.

Seal sighting rates: During the 1996 OBC survey (Harris *et al.,* 2001) the sighting rate for all seals during periods when airguns were not operating was 0.63 ind/h. The sighting rate during non-seismic periods was 0.046 ind/h for the survey in Foggy Island Bay, just east of Prudhoe Bay (Aerts *et al.,* 2008). The OBC survey that took place at Oliktok Point recorded 0.0674 ind/h when airguns were not operating (Hauser *et al.,* 2008), and the maximum sighting rate during the Simpson Lagoon OBC seismic survey was 0.030 ind/h (HDR, 2012).

The average seal sighting rate, based on these four surveys, was 0.193 ind/h. The maximum was 0.63 ind/h and the minimum 0.03 ind/h. Using the proportion of ringed, bearded, and spotted seals as mentioned above, BP estimated the average and maximum sighting rates (ind/h) for each of the three seal species (Table 6 in the application and Table 7 here).

TABLE 7—ESTIMATED SUMMER DENSITIES OF WHALES AND SIGHTING RATES OF SEALS (AVERAGE AND MAXIMUM) FOR THE PROPOSED FOGGY ISLAND BAY SURVEY. DENSITIES ARE PROVIDED IN NUMBER OF INDIVIDUALS PER SQUARE KILOMETER (IND/KM²), AND SIGHTING RATES ARE IN NUMBER OF INDIVIDUALS PER HOUR (IND/H). NO DENSITIES OR SIGHTING RATES WERE ESTIMATED FOR EXTRALIMITAL SPECIES

Species	Summer densities (ind/km²)	
	Average	Maximum
Bowhead whale	0.0015	0.0055
Beluga whale	0.0028	0.0105
	Summer sighting rates (ind/h)	
	Average	Maximum
Ringed seal	0.122	0.397
Bearded seal	0.033	0.107
Spotted seal	0.039	0.126

5. Marine Mammal Density Summary

For the purpose of calculating the potential number of beluga and bowhead whale exposures to received sound levels of ≥160 dB re 1 μPa, BP used the minimum density from Tables 5 and 6 in this document as the average density. The reason for this decision is that the 2012 data only covered block 1 and were considered more representative. To derive a maximum estimated number of exposures, BP used the average densities from Tables 5 and 6 in this document. BP considered this approach reasonable because the 2013 beluga and bowhead whale sighting data included areas outside the zone of influence of the proposed project. For example, in 2013, only 3 of the 89 beluga sightings were seen in block 1. Table 7 in this document summarizes the densities used in the calculation of potential number of exposures.

Level A and Level B Harassment Zone Distances

For the proposed 2014 shallow geohazard survey, BP used existing sound source verification (SSV) measurements to establish distances to received sound pressure levels (SPLs). Airgun arrays consist of a cluster of independent sources. Because of this, and many other factors, sounds generated by these arrays therefore do not propagate evenly in all directions. BP included both broadside and endfire measurements of the array in calculating distances to the various received sound levels. Broadside and endfire measurements are not applicable to mitigation gun measurements.

Seven SSV measurements exist of 20–400 in³ airgun arrays in the shallow water environment of the Beaufort Sea that were considered to be representative of the proposed 30 in³ airgun arrays. These measurements were from 2008 (n = 4), 2011 (n = 1) and 2012 (n = 2), all in water depths less than about 50 ft. For the 5 in³ mitigation gun, measured distances of a 10 in³ mitigation gun from four shallow hazard SSV surveys in the Beaufort Sea were used: One in 2007, two in 2008, and one in 2011. Table 7A in BP's application shows average, maximum, and minimum measured distances to each of the four received SPL rms levels for 20–40 in³ arrays and 10 in³ single gun. The mitigation radii of the proposed 30 in³ airgun arrays and 5 in³ gun were derived from the average distance of the 20–40 in³ and the 10 in³ SSV measurements, respectively (see Table 8 in BP's application). Distances to sound pressure levels of 190, 180, and 160 dB re 1 μPa, generated by the proposed geophysical equipment is much lower than for airguns (see Table 7B in BP's application). The operating frequency of the sidescan sonar is within hearing range of toothed whales only, with a distance of 50 m to 180 dB re 1 μPa (rms) and 230 m to 160 dB re 1 μPa (rms) (Warner & McCrodan, 2011). Sounds generated by the subbottom profiler are within the hearing range of all marine mammal species occurring in the area but do not produce sounds strong enough to reach sound pressure levels of 190 or 180 dB re 1 μPa (rms). The distance to 160 dB re 1 μPa (rms) is estimated at 30 m (Warner & McCrodan, 2011). BP considered the distances derived from the existing airgun arrays as summarized in Table 7A in BP's application as representative for the proposed 30 in³ arrays. NMFS concurs with this approach.

Table 8 in this document presents the radii used to estimate take (160 dB isopleth) and to implement mitigation measures (180 dB and 190 dB isopleths) from the full airgun array and the 5 in³ mitigation gun. However, take is only estimated using the larger radius of the full airgun array.

TABLE 8—DISTANCES (IN METERS) TO BE USED FOR ESTIMATING TAKE BY LEVEL B HARASSMENT AND FOR MITIGATION PURPOSES DURING THE PROPOSED 2014 NORTH PRUDHOE BAY 2014 SEISMIC SURVEY

Airgun discharge volume (in³)	190 dB re 1 μPa	180 dB re 1 μPa	160 dB re 1 μPa
30 in³	70	200	1,600
5 in³	20	50	600

Numbers of Marine Mammals Potentially Taken by Harassment

The potential number of marine mammals that might be exposed to the 160 dB re 1 μPa (rms) SPL was calculated differently for cetaceans and pinnipeds, as described in Section 6.3 of BP's application and next here. BP did not calculate take from the subbottom profiler or from the sidescan sonar for toothed whales. Based on the distance to the 160 dB re 1 μPa (rms) isopleths for these sources and the fact that NMFS proposes to authorize the maximum estimated exposure estimate, the extremely minimal number of exposures that would result from use of these sources is already accounted for in the airgun exposure estimates.

1. Number of Cetaceans Potentially Taken by Harassment

The potential number of bowhead and beluga whales that might be exposed to the 160 dB re 1 μPa (rms) sound pressure level was calculated by multiplying:

- The expected bowhead and beluga density as provided in Tables 5 and 6 in this document (Tables 4 and 5 in BP's application);
- The anticipated area around each source vessel that is ensonified by the 160 dB re 1 μPa (rms) sound pressure level; and
- The estimated number of 24-hr days that the source vessels are operating.

The area expected to be ensonified by the 30 in³ array was determined based on the maximum distance to the 160 dB re 1 μPa (rms) SPL as determined from the maximum 20–40 in³ array measurements (Table 7A in BP's application), which is 1.6 km. Based on a radius of 1.6 km, the 160 dB isopleth used in the exposure calculations was 8 km².

The estimated number of 24-hr days of airgun operations is 7.5 days (180 hours), not including downtime. Downtime is related to weather, equipment maintenance, mitigation implementation, and other circumstances.

Average and maximum estimates of the number of bowhead and beluga whales potentially exposed to sound pressure levels of 160 dB re 1μPa (rms) or more are summarized in Table 9 in BP's application. Species such as gray whale, killer whale, and harbor porpoise are not expected to be encountered but might be present in very low numbers; the maximum expected number of exposures for these species provided in Table 9 of BP's application is based on the likelihood of incidental occurrences.

The average and maximum number of bowhead whales potentially exposed to sound levels of 160 dB re 1μPa (rms) or more is estimated at 0 and 1, respectively. BP requested to take three bowheads to account for chance encounters. The average and maximum number of potential beluga exposures to 160 dB is 0 and 1, respectively. Belugas are known to show aggregate behavior and can occur in large numbers in nearshore zones, as evidenced by the sighting at Endicott in August 2013. Therefore, for the unlikely event that a group of belugas appears within the 160 dB isopleth during the proposed seismic survey, BP added a number of 75 to the requested authorization. Chance encounters with small numbers of other whale species are possible.

These estimated exposures do not take into account the proposed mitigation measures, such as PSOs watching for animals, shutdowns or power downs of the airguns when marine mammals are seen within defined ranges, and ramp-up of airguns.

2. Number of Pinnipeds Potentially Taken by Harassment

The estimated number of seals that might be exposed to pulsed sounds of 160 dB re 1 μPa (rms) was calculated by multiplying:

- The expected species specific sighting rate as provided in Table 7 in this document (also in Table 6 in BP's application); and
- The total number of hours that each source vessel will be operating during the data acquisition period.

The estimated number of hours that airguns will be operating is 180 hours (7.5 days of 24 hour operations). The resulting average and maximum number of ringed, bearded, and spotted seal exposures based on 180 hours of airgun operations are summarized in Table 9 of BP's application. BP assumed that all seal sightings would occur within the 160 dB isopleth. These estimated exposures do not take into account the proposed mitigation measures, such as PSOs watching for animals, shutdowns or power downs of the airguns when marine mammals are seen within defined ranges, and ramp-up of airguns.

Estimated Take by Harassment Summary

Table 9 here outlines the density estimates used to estimate Level B takes, the proposed Level B harassment take levels, the abundance of each species in the Beaufort Sea, the percentage of each species or stock estimated to be taken, and current population trends. As explained earlier in this document, NMFS used the maximum density estimates or sighting rates and proposes to authorize the maximum estimates of exposures. Additionally, as explained earlier, density estimates are not available for species that are uncommon in the proposed survey area.

TABLE 9—DENSITY ESTIMATES OR SPECIES SIGHTING RATES, PROPOSED LEVEL B HARASSMENT TAKE LEVELS, SPECIES OR STOCK ABUNDANCE, PERCENTAGE OF POPULATION PROPOSED TO BE TAKEN, AND SPECIES TREND STATUS

Species	Density (#/km²)	Sighting rate (ind/hr)	Proposed Level B take	Abundance	Percentage of population	Trend
Beluga whale	0.0105		75	39,258	0.19	No reliable information.
Killer whale	NA		1	552	0.18	Stable.
Harbor porpoise	NA		1	48,215	>0.01	No reliable information.
Bowhead whale	0.0055		3	16,892	0.02	Increasing.
Gray whale	NA		1	19,126	0.01	Increasing.
Bearded seal		0.107	19	155,000	0.01	No reliable information.
Ringed seal		0.397	71	300,000	0.02	No reliable information.
Spotted seal		0.126	23	141,479	0.02	No reliable information.
Ribbon seal		NA	1	49,000	>0.01	No reliable information.

Analysis and Preliminary Determinations

Negligible Impact

Negligible impact is ''an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival'' (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through behavioral harassment, NMFS must consider other factors, such as the likely nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), as well as the number and nature of estimated Level A harassment takes, the number of estimated mortalities, effects on habitat, and the status of the species.

No injuries or mortalities are anticipated to occur as a result of BP's proposed shallow geohazard survey, and none are proposed to be authorized. Additionally, animals in the area are not expected to incur hearing impairment (i.e., TTS or PTS) or non-auditory physiological effects. The number of takes that are anticipated and authorized are expected to be limited to short-term Level B behavioral harassment. While the airguns will be operated continuously for about 7.5 days, the project time frame will occur when cetacean species are typically not found in the project area or are found only in low numbers. While pinnipeds are likely to be found in the proposed project area more frequently, their distribution is dispersed enough that they likely will not be in the Level B harassment zone continuously. As mentioned previously in this document, pinnipeds appear to be more tolerant of anthropogenic sound than mystiectes.

The use of sidescan sonar, multibeam echosounder, and subbottom profiler continuously for 7.5 days will not negatively impact marine mammals as the majority of these instruments are operated outside of the hearing frequencies of marine mammals.

The Alaskan Beaufort Sea is part of the main migration route of the Western Arctic stock of bowhead whales. However, the seismic survey has been planned to occur when the majority of the population is found in the Canadian Beaufort Sea. Operation of airguns and other sound sources will cease by midnight on August 25 before the main fall migration begins and well before cow/calf pairs begin migrating through the area. Additionally, several locations within the Beaufort Sea serve as feeding grounds for bowhead whales. However, as mentioned earlier in this document, the primary feeding grounds are not found in Foggy Island Bay. The majority of bowhead whales feed in the Alaskan Beaufort Sea during the fall migration period, which will occur after the cessation of the survey.

Belugas that migrate through the U.S. Beaufort Sea typically do so farther offshore (more than 37 mi [60 km]) and in deeper waters (more than 656 ft [200 m]) than where the proposed survey activities would occur. Gray whales are rarely sighted this far east in the U.S. Beaufort Sea. Additionally, there are no known feeding grounds for gray whales in the Foggy Island Bay area. The most northern feeding sites known for this species are located in the Chukchi Sea near Hanna Shoal and Point Barrow. The other cetacean species for which take is proposed are uncommon in Foggy Island Bay, and no known feeding or calving grounds occur in Foggy Island Bay for these species. Based on these factors, exposures of cetaceans to anthropogenic sounds are not expected to last for prolonged periods (i.e., several days) since they are not known to remain in the area for extended periods of time in July and August. Also, the shallow water location of the survey makes it unlikely that cetaceans would remain in the area for prolonged periods. Based on all of this information, the proposed project is not anticipated to affect annual rates of recruitment or survival for cetaceans in the area.

Ringed seals breed and pup in the Alaskan Beaufort Sea; however, the proposed survey will occur outside of the breeding and pupping seasons. The Beaufort Sea does not provide suitable habitat for the other three ice seal species for breeding and pupping. Based on this information, the proposed project is not anticipated to affect annual rates of recruitment or survival for pinnipeds in the area.

Of the nine marine mammal species for which take is authorized, one is listed as endangered under the ESA—the bowhead whale—and two are listed as threatened—ringed and bearded seals. Schweder *et al.* (2009) estimated the yearly growth rate to be 3.2% (95% CI = 0.5–4.8%) between 1984 and 2003 using a sight-resight analysis of aerial photographs. There are currently no reliable data on trends of the ringed and bearded seal stocks in Alaska. The ribbon seal is listed as a species of concern under the ESA. Certain stocks or populations of gray, killer, and beluga whales and spotted seals are listed as endangered or are proposed for listing under the ESA; however, none of those stocks or populations occur in the activity area. There is currently no established critical habitat in the project area for any of these nine species.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from BP's proposed shallow geohazard survey in Foggy Island Bay, Beaufort Sea, Alaska, will have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

The requested takes proposed to be authorized represent less than 1% of all populations or stocks (see Table 9 in this document). These take estimates represent the percentage of each species or stock that could be taken by Level B behavioral harassment if each animal is taken only once. The numbers of marine mammals taken are small relative to the affected species or stock sizes. In addition, the mitigation and monitoring measures (described previously in this document) proposed for inclusion in the IHA (if issued) are expected to reduce even further any potential disturbance to marine mammals. NMFS preliminarily finds that small numbers of marine mammals will be taken relative to the populations of the affected species or stocks. Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

Relevant Subsistence Uses

The disturbance and potential displacement of marine mammals by sounds from the proposed survey are the principal concerns related to subsistence use of the area. Subsistence remains the basis for Alaska Native culture and community. Marine mammals are legally hunted in Alaskan waters by coastal Alaska Natives. In rural Alaska, subsistence activities are often central to many aspects of human existence, including patterns of family life, artistic expression, and community religious and celebratory activities. Additionally, the animals taken for subsistence provide a significant portion of the food that will last the community throughout the year. The main species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses, and polar bears. (As mentioned previously in this document, both the walrus and the polar bear are under the USFWS' jurisdiction.) The importance of each of these species varies among the communities and is largely based on availability.

Residents of the village of Nuiqsut are the primary subsistence users in the project area. The communities of Barrow and Kaktovik also harvest resources that pass through the area of interest but do not hunt in or near the Foggy Island Bay area. Subsistence hunters from all three communities conduct an annual hunt for autumn-migrating bowhead whales. Barrow also conducts a bowhead hunt in spring. Residents of all three communities hunt seals. Other subsistence activities include fishing, waterfowl and seaduck harvests, and hunting for walrus, beluga whales, polar bears, caribou, and moose.

Nuiqsut is the community closest to the seismic survey area (approximately 73 mi [117.5 km] southwest). Nuiqsut hunters harvest bowhead whales only during the fall whaling season (Long, 1996). In recent years, Nuiqsut whalers have typically landed three or four whales per year. Nuiqsut whalers concentrate their efforts on areas north and east of Cross Island, generally in water depths greater than 66 ft (20 m; Galginaitis, 2009). Cross Island is the principal base for Nuiqsut whalers while they are hunting bowheads (Long, 1996). Cross Island is located approximately 10 mi (16 km) from the closest boundary of the survey area.

Kaktovik whalers search for whales east, north, and occasionally west of Kaktovik. Kaktovik is located approximately 91 mi (146.5 km) east of Foggy Island Bay. The western most reported harvest location was about 13 mi (21 km) west of Kaktovik, near 70°10′ N., 144°11′ W. (Kaleak, 1996). That site is about 80 mi (129 km) east of the proposed survey area.

Barrow whalers search for whales much farther from the Foggy Island Bay area—about 200+ mi (322+ km) to the west. Barrow hunters have expressed concerns about ''downstream'' effects to bowhead whales during the westward fall migration; however, BP will cease airgun operations prior to the start of the fall migration.

Beluga whales are not a prevailing subsistence resource in the communities of Kaktovik and Nuiqsut. Kaktovik hunters may harvest one beluga whale in conjunction with the bowhead hunt; however, it appears that most households obtain beluga through exchanges with other communities. Although Nuiqsut hunters have not hunted belugas for many years while on Cross Island for the fall hunt, this does not mean that they may not return to this practice in the future. Data presented by Braund and Kruse (2009) indicate that only 1% of Barrow's total harvest between 1962 and 1982 was of beluga whales and that it did not account for any of the harvested animals between 1987 and 1989.

Ringed seals are available to subsistence users in the Beaufort Sea year-round, but they are primarily hunted in the winter or spring due to the rich availability of other mammals in the summer. Bearded seals are primarily hunted during July in the Beaufort Sea; however, in 2007, bearded seals were harvested in the months of August and September at the mouth of the Colville River Delta, which is approximately 50+ mi (80+ km) from the proposed survey area. However, this sealing area can reach as far east as Pingok Island, which is approximately 20 mi (32 km) west of the survey area. An annual bearded seal harvest occurs in the vicinity of Thetis Island (which is a considerable distance from Foggy Island Bay) in July through August. Approximately 20 bearded seals are harvested annually through this hunt. Spotted seals are harvested by some of the villages in the summer months. Nuiqsut hunters typically hunt spotted seals in the nearshore waters off the Colville River Delta. The majority of the more established seal hunts that occur in the Beaufort Sea, such as the Colville delta area hunts, are located a significant distance (in some instances 50 mi [80 km] or more) from the project area.

Potential Impacts to Subsistence Uses

NMFS has defined ''unmitigable adverse impact'' in 50 CFR 216.103 as: ''. . . an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.''

Noise and general activity during BP's proposed shallow geohazard survey have the potential to impact marine mammals hunted by Native Alaskan. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously) is avoidance of the ensonified area. In the case of bowhead whales, this often means that the animals divert from their normal migratory path by several kilometers. Helicopter activity, although not really anticipated, also has the potential to disturb cetaceans and pinnipeds by causing them to vacate the area. Additionally, general vessel presence in the vicinity of traditional hunting areas could negatively impact a hunt. Native knowledge indicates that bowhead whales become increasingly ''skittish'' in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing (which makes harvesting more difficult). Additionally, natives report that bowheads exhibit angry behaviors in the presence of seismic, such as tail-slapping, which translate to danger for nearby subsistence harvesters.

Plan of Cooperation or Measures To Minimize Impacts to Subsistence Hunts

Regulations at 50 CFR 216.104(a)(12) require IHA applicants for activities that take place in Arctic waters to provide a Plan of Cooperation or information that identifies what measures have been taken and/or will be taken to minimize adverse effects on the availability of marine mammals for subsistence purposes. BP has begun discussions with the Alaska Eskimo Whaling Commission (AEWC) to develop a Conflict Avoidance Agreement (CAA) intended to minimize potential interference with bowhead subsistence hunting. BP also attended and participated in meetings with the AEWC on December 13, 2013, and will attend future meetings to be scheduled in 2014. The CAA, when executed, will describe measures to minimize any adverse effects on the availability of bowhead whales for subsistence uses.

The North Slope Borough Department of Wildlife Management (NSB–DWM) will be consulted, and BP plans to present the project to the NSB Planning Commission in 2014. BP will hold meetings in the community of Nuiqsut to present the proposed project, address questions and concerns from community members, and provide them with contact information of project management to which they can direct concerns during the survey. During the NMFS Open-Water Meeting in Anchorage in 2013, BP presented their proposed projects to various stakeholders that were present during this meeting.

BP will continue to engage with the affected subsistence communities regarding its Beaufort Sea activities. As in previous years, BP will meet formally and/or informally with several stakeholder entities: The NSB Planning Department, NSB–DWM, NMFS, AEWC, Inupiat Community of the Arctic Slope, Inupiat History Language and Culture Center, USFWS, Nanuq and Walrus Commissions, and Alaska Department of Fish & Game.

Project information was provided to and input on subsistence obtained from the AEWC and Nanuq Commission at the following meetings:

• AEWC, October 17, 2013; and
• Nanuq Commission, October 17, 2013.

Additional meetings with relevant stakeholders will be scheduled and a record of attendance and topics discussed will be maintained and submitted to NMFS.

BP proposes to implement several mitigation measures to reduce impacts on the availability of marine mammals for subsistence hunts in the Beaufort Sea. Many of these measures were developed from the 2013 CAA and previous NSB Development Permits. In addition to the measures listed next, BP will cease all airgun operations by midnight on August 25 to allow time for the Beaufort Sea communities to prepare for their fall bowhead whale hunts prior to the beginning of the fall westward migration through the Beaufort Sea. Some of the measures mentioned next have been mentioned previously in this document:

• PSOs on board vessels are tasked with looking out for whales and other marine mammals in the vicinity of the vessel to assist the vessel captain in avoiding harm to whales and other marine mammals.;
• Vessels and aircraft will avoid areas where species that are sensitive to noise or vessel movements are concentrated;
• Communications and conflict resolution are detailed in the CAA. BP will participate in the Communications Center that is operated annually during the bowhead subsistence hunt;
• Communications with the village of Nuiqsut to discuss community questions or concerns including all subsistence hunting activities. Pre-project meeting(s) with Nuiqsut

representatives will be held at agreed times with groups in the community of Nuiqsut. If additional meetings are requested, they will be set up in a similar manner;

- Contact information for BP will be provided to community members and distributed in a manner agreed at the community meeting;
- BP has contracted with a liaison from Nuiqsut who will help coordinate meetings and serve as an additional contact for local residents during planning and operations; and
- Inupiat Communicators will be employed and work on seismic source vessels. They will also serve as PSOs.

Unmitigable Adverse Impact Analysis and Preliminary Determination

BP has adopted a spatial and temporal strategy for its Foggy Island Bay survey that should minimize impacts to subsistence hunters. First, BP's activities will not commence until after the spring hunts have occurred. Second, BP will cease all airgun operations by midnight on August 25 prior to the start of the bowhead whale fall westward migration and any fall subsistence hunts by Beaufort Sea communities. Foggy Island Bay is not commonly used for subsistence hunts. Although some seal hunting co-occurs temporally with BP's proposed survey, the locations do not overlap. BP's presence will not place physical barriers between the sealers and the seals. Additionally, BP will work closely with the closest affected communities and support Communications Centers and employ local Inupiat Communicators. Based on the description of the specified activity, the measures described to minimize adverse effects on the availability of marine mammals for subsistence purposes, and the proposed mitigation and monitoring measures, NMFS has preliminarily determined that there will not be an unmitigable adverse impact on subsistence uses from BP's proposed activities.

Endangered Species Act (ESA)

Within the project area, the bowhead whale is listed as endangered and the ringed and bearded seals are listed as threatened under the ESA. NMFS' Permits and Conservation Division has initiated consultation with staff in NMFS' Alaska Region Protected Resources Division under section 7 of the ESA on the issuance of an IHA to BP under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of an IHA.

National Environmental Policy Act (NEPA)

NMFS is currently conducting an analysis, pursuant to NEPA, to determine whether this proposed IHA may have a significant effect on the human environment. This analysis will be completed prior to the issuance or denial of this proposed IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to BP for conducting a shallow geohazard survey in the Foggy Island Bay area of the Beaufort Sea, Alaska, during the 2014 open-water season, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. The proposed IHA language is provided next.

This section contains a draft of the IHA itself. The wording contained in this section is proposed for inclusion in the IHA (if issued).

1. This IHA is valid from July 1, 2014, through September 30, 2014.

2. This IHA is valid only for activities associated with open-water shallow geohazard surveys and related activities in the Beaufort Sea. The specific areas where BP's surveys will be conducted are within the Foggy Island Bay Area, Beaufort Sea, Alaska, as shown in Figure 1 of BP's IHA application.

3. Species Authorized and Level of Take:

a. The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the Beaufort Sea:

i. Odontocetes: 75 Beluga whales; 1 killer whale; and 1 harbor porpoise.

ii. Mysticetes: 3 Bowhead whales and 1 gray whale.

iii. Pinnipeds: 71 Ringed seals; 19 bearded seals; 23 spotted seals; and 1 ribbon seal.

iv. If any marine mammal species not listed in conditions 3(a)(i) through (iii) are encountered during seismic survey operations and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms) for impulse sources, then the Holder of this IHA must shut-down the sound source to avoid take.

b. The taking by injury (Level A harassment) serious injury, or death of any of the species listed in condition 3(a) or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this IHA.

4. The authorization for taking by harassment is limited to the following acoustic sources (or sources with comparable frequency and intensity) and from the following activities:

a. 30 in^3 airgun arrays;

b. 10 in^3 and/or 5 in^3 mitigation airguns; and

c. Vessel activities related to the OBS seismic survey.

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Alaska Regional Administrator or his designee and the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, or her designee.

6. The holder of this Authorization must notify the Chief of the Permits and Conservation Division, Office of Protected Resources, at least 48 hours prior to the start of collecting seismic data (unless constrained by the date of issuance of this IHA in which case notification shall be made as soon as possible).

7. Mitigation Requirements: The Holder of this Authorization is required to implement the following mitigation requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

a. General Vessel and Aircraft Mitigation

i. Avoid concentrations or groups of whales by all vessels under the direction of BP. Operators of support vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

ii. The vessel shall be operated at speeds necessary to ensure no physical contact with whales occurs. If the vessel approaches within 1.6 km (1 mi) of observed whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the whales by taking one or more of the following actions, as appropriate:

A. Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);

B. Steering around the whale(s) if possible;

C. Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

D. Operating the vessel(s) to avoid causing a whale to make multiple changes in direction;

E. Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged; and

F. Reducing vessel speed to less than 9 knots when weather conditions reduce visibility.

iii. When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.

iv. In the event that any aircraft (such as helicopters) are used to support the planned survey, the mitigation measures below would apply:

A. Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level when within 0.3 mile (0.5 km) of groups of whales.

B. Helicopters shall not hover or circle above or within 0.3 mile (0.5 km) of groups of whales.

C. At all other times, aircraft should attempt not to fly below 1,000 ft except during emergencies and take-offs and landings.

b. Seismic Airgun Mitigation

i. Whenever a marine mammal is detected outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion radius, calculate and implement an alternative ship speed or track or de-energize the airgun array, as described in condition 7(b)(iv) below.

ii. *Exclusion Zones:*

A. Establish and monitor with trained PSOs an exclusion zone for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB re 1 μPa rms. This radius is estimated to be 200 m from the seismic source for the 30 in^3 airgun arrays and 50 m for a single 5 in^3 airgun.

B. Establish and monitor with trained PSOs an exclusion zone for pinnipeds surrounding the airgun array on the source vessel where the received level would be 190 dB re 1 μPa rms. This radius is estimated to be 70 m from the seismic source for the 30 in^3 airgun arrays and 20 m for a single 5 in^3 airgun.

iii. *Ramp-up:*

A. A ramp-up, following a cold start, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp-up from a cold start cannot begin.

B. Ramp-up procedures from a cold start shall be delayed if a marine mammal is sighted within the exclusion zone during the 30-minute period prior to the ramp up. The delay shall last until the marine mammal(s) has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 or 30 minutes. The 15 minutes applies to pinnipeds, while a 30 minute observation period applies to cetaceans.

C. A ramp-up, following a shutdown, can be applied if the marine mammal(s) for which the shutdown occurred has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 minutes (pinnipeds) or 30 minutes (cetaceans).

D. If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures shall be implemented. Only if the PSO watch has been suspended, a 30-minute clearance of the exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

E. The seismic operator and PSOs shall maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

F. The ramp-up will be conducted by doubling the number of operating airguns at 5-minute intervals, starting with the smallest gun in the array.

iv. *Power-down/Shutdown:*

A. The airgun array shall be immediately powered down (reduction in the number of operating airguns such that the radii of exclusion zones are decreased) whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.

B. If a marine mammal is already within the exclusion zone when first detected, the airguns shall be powered down immediately.

C. Following a power-down, ramp-up to the full airgun array shall not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone of the full array, or has not been seen within the zone for 15 minutes (pinnipeds) or 30 minutes (cetaceans).

D. If a marine mammal is sighted within or about to enter the 190 or 180 dB (rms) applicable exclusion zone of the single mitigation airgun, the airgun array shall be shutdown immediately.

E. Airgun activity after a complete shutdown shall not resume until the marine mammal has cleared the exclusion zone of the full array. The animal will be considered to have cleared the exclusion zone as described above under ramp-up procedures.

v. *Poor Visibility Conditions:*

A. If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.

B. If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

C. The mitigation airgun will be operated at approximately one shot per minute and will not be operated for longer than three hours in duration during daylight hours and good visibility. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, use of the mitigation airgun may be initiated 30 minutes before darkness or low visibility conditions occur and may be operated until the start of the next seismic acquisition line. The mitigation gun must still be operated at approximately one shot per minute.

c. Subsistence Mitigation

i. Airgun and echosounder, sonar, and subbottom profiler operations must cease no later than midnight on August 25, 2014;

ii. BP will participate in the Communications Center that is operated annually during the bowhead subsistence hunt; and

iii. Inupiat communicators will work on the seismic vessels.

8. Monitoring

a. The holder of this Authorization must designate biologically-trained, on-site individuals (PSOs) to be onboard the source vessels, who are approved in advance by NMFS, to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting sound on marine mammals.

i. PSO teams shall consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the PSO team onboard the survey vessel. New observers shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

ii. Crew leaders and most other biologists serving as observers will be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in

Alaska, the Canadian Beaufort, or other offshore areas in recent years.

iii. PSOs shall complete a training session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2014 open-water season. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs. An observers' handbook, adapted for the specifics of the planned survey program will be reviewed as part of the training.

iv. If there are Alaska Native PSOs, the PSO training that is conducted prior to the start of the survey activities shall be conducted with both Alaska Native PSOs and biologist PSOs being trained at the same time in the same room. There shall not be separate training courses for the different PSOs.

v. Crew members should not be used as primary PSOs because they have other duties and generally do not have the same level of expertise, experience, or training as PSOs, but they could be stationed on the fantail of the vessel to observe the near field, especially the area around the airgun array and implement a power-down or shutdown if a marine mammal enters the exclusion zone).

vi. If crew members are to be used as PSOs, they shall go through some basic training consistent with the functions they will be asked to perform. The best approach would be for crew members and PSOs to go through the same training together.

vii. PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

viii. BP shall train its PSOs to follow a scanning schedule that consistently distributes scanning effort according to the purpose and need for observations. For example, the schedule might call for 60% of scanning effort to be directed toward the near field and 40% at the far field. All PSOs should follow the same schedule to ensure consistency in their scanning efforts.

ix. PSOs shall be trained in documenting the behaviors of marine mammals. PSOs should simply record the primary behavioral state (i.e., traveling, socializing, feeding, resting, approaching or moving away from vessels) and relative location of the observed marine mammals.

b. To the extent possible, PSOs should be on duty for four (4) consecutive hours or less, although more than one four-hour shift per day is acceptable; however, an observer shall not be on duty for more than 12 hours in a 24-hour period.

c. Monitoring is to be conducted by the PSOs onboard the active seismic vessels to ensure that no marine mammals enter the appropriate exclusion zone whenever the seismic acoustic sources are on and to record marine mammal activity as described in condition 8(f). Two PSOs will be present on the vessel. At least one PSO shall monitor for marine mammals at any time during daylight hours.

d. At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the PSO(s) on-watch. If a marine mammal is within or closely approaching its designated exclusion zone, the seismic acoustic sources must be immediately powered down or shutdown (in accordance with condition 7(b)(iv)).

e. Observations by the PSOs on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

f. All marine mammal observations and any airgun power-down, shut-down and ramp-up will be recorded in a standardized format. Data will be entered into a custom database. The accuracy of the data entry will be verified daily through QA/QC procedures. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to other programs for further processing and archiving.

g. Monitoring shall consist of recording:

i. The species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc);

ii. The time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at:

A. Any time a marine mammal is sighted (including pinnipeds hauled out on barrier islands),

B. At the start and end of each watch, and

C. During a watch (whenever there is a change in one or more variable);

iii. The identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s);

iv. Any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO's ability to detect marine mammals);

v. Any adjustments made to operating procedures; and

iv. Visibility during observation periods so that total estimates of take can be corrected accordingly.

h. BP shall work with its observers to develop a means for recording data that does not reduce observation time significantly.

i. PSOs shall use the best possible positions for observing (e.g., outside and as high on the vessel as possible), taking into account weather and other working conditions. PSOs shall carefully document visibility during observation periods so that total estimates of take can be corrected accordingly.

j. PSOs shall scan systematically with the unaided eye and reticle binoculars, and other devices.

k. PSOs shall attempt to maximize the time spent looking at the water and guarding the exclusion radii. They shall avoid the tendency to spend too much time evaluating animal behavior or entering data on forms, both of which detract from their primary purpose of monitoring the exclusion zone.

l. Night-vision equipment (Generation 3 binocular image intensifiers, or equivalent units) shall be available for use during low light hours, and BP shall continue to research methods of detecting marine mammals during periods of low visibility.

m. PSOs shall understand the importance of classifying marine mammals as ''unknown'' or ''unidentified'' if they cannot identify the animals to species with confidence. In those cases, they shall note any information that might aid in the identification of the marine mammal sighted. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.

n. Additional details about unidentified marine mammal sightings, such as ''blow only'', mysticete with (or without) a dorsal fin, ''seal splash'', etc., shall be recorded.

o. BP shall conduct a fish and airgun sound monitoring program as described in the IHA application and further refined in consultation with an expert panel.

9. *Data Analysis and Presentation in Reports:*

a. Estimation of potential takes or exposures shall be improved for times with low visibility (such as during fog or darkness) through interpolation or possibly using a probability approach. Those data could be used to interpolate possible takes during periods of restricted visibility.

b. Water depth should be continuously recorded by the vessel and for each marine mammal sighting. Water depth should be accounted for in the analysis of take estimates.

c. BP shall be very clear in their report about what periods are considered ''non-seismic'' for analyses.

d. BP shall examine data from ASAMM and other such programs to assess possible impacts from their seismic survey.

e. To better assess impacts to marine mammals, data analysis shall be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:

i. Data for periods when a seismic array is active and when it is not; and

ii. The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

f. To help evaluate the effectiveness of PSOs and more effectively estimate take, if appropriate data are available, BP shall perform analysis of sightability curves (detection functions) for distance-based analyses.

g. BP should improve take estimates and statistical inference into effects of the activities by incorporating the following measures:

i. Reported results from all hypothesis tests should include estimates of the associated statistical power when practicable.

ii. Estimate and report uncertainty in all take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available.

10. *Reporting Requirements:* The Holder of this Authorization is required to:

a. A report will be submitted to NMFS within 90 days after the end of the proposed seismic survey. The report will summarize all activities and monitoring results conducted during in-water seismic surveys. The Technical Report will include the following:

i. Summary of project start and end dates, airgun activity, number of guns, and the number and circumstances of implementing ramp-up, power down, shutdown, and other mitigation actions;

ii. Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

iii. Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

iv. Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), and group sizes;

v. Analyses of the effects of survey operations;

vi. Sighting rates of marine mammals during periods with and without seismic survey activities (and other variables that could affect detectability), such as:

A. Initial sighting distances versus survey activity state;

B. Closest point of approach versus survey activity state;

C. Observed behaviors and types of movements versus survey activity state;

D. Numbers of sightings/individuals seen versus survey activity state;

E. Distribution around the source vessels versus survey activity state; and

F. Estimates of exposures of marine mammals to Level B harassment thresholds based on presence in the 160 dB harassment zone.

b. The draft report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. The draft report will be considered the final report for this activity under this Authorization if NMFS has not provided comments and recommendations within 90 days of receipt of the draft report.

c. BP will present the results of the fish and airgun sound study to NMFS in a detailed report.

11. Notification of Dead or Injured Marine Mammals

a. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), BP 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, and the Alaska Regional Stranding Coordinators. The report would 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 hours 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 hours 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 BP to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. BP would not be able to resume their activities until notified by NMFS via letter, email, or telephone.

b. In the event that BP 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), BP would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators. The report would include the same information identified in the paragraph above. Activities would be able to continue while NMFS reviews the circumstances of the incident. NMFS would work with BP to determine whether modifications in the activities are appropriate.

c. In the event that BP 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), BP would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the NMFS Alaska Stranding Hotline and/or by email to the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. BP would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

12. Activities related to the monitoring described in this IHA do not require a separate scientific research

permit issued under section 104 of the MMPA.

13. BP is required to comply with the Reasonable and Prudent Measures and Terms and Conditions of the Incidental Take Statement (ITS) corresponding to NMFS' Biological Opinion.

14. A copy of this IHA and the ITS must be in the possession of all contractors and PSOs operating under the authority of this IHA.

15. Penalties and Permit Sanctions: Any person who violates any provision of this Incidental Harassment Authorization is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA.

16. This Authorization may be modified, suspended or withdrawn if the Holder fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals, or if there is an unmitigable adverse impact on the availability of such species or stocks for subsistence uses.

Request for Public Comments

NMFS requests comment on our analysis, the draft authorization, and any other aspect of the Notice of Proposed IHA for BP's proposed shallow geohazard survey in the Foggy Island Bay area of the Beaufort Sea, Alaska, during the 2014 open-water season. Please include with your comments any supporting data or literature citations to help inform our final decision on BP's request for an MMPA authorization.

Dated: April 10, 2014.

Donna S. Wieting,

Director, Office of Protected Resources, National Marine Fisheries Service.

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