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Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to an Exploration Drilling Program Near Camden Bay, Beaufort Sea, Alaska; Notice

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XU80

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to an Exploration Drilling Program Near Camden Bay, Beaufort Sea, AK

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

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

SUMMARY: NMFS received an application from Shell Offshore Inc. (Shell) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to offshore exploration drilling on Outer Continental Shelf (OCS) leases in the Beaufort Sea, Alaska. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to Shell to take, by Level B harassment only, six species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than May 19, 2010.

ADDRESSES: Comments on the application should be addressed to Michael Payne, Chief, Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is *PR1.0648–XU80@noaa.gov.* NMFS is not responsible for e-mail comments sent to addresses other than the one provided here. Comments sent via e-mail, including all attachments, must not exceed a 10-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 (for example, name, address, *etc.*) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

A copy of the application 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.* The following associated documents are also available at the same internet address: Shell's 2010 Exploration Drilling Communication Plan Beaufort Sea, Alaska, and Shell's 2010 Plan of Cooperation (POC) Camden Bay, Alaska. 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) 713–2289, ext 156.

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 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."

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

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

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

Summary of Request

NMFS received an application on May 11, 2009, from Shell for the taking, by harassment, of marine mammals incidental to offshore exploration drilling on OCS leases in the Beaufort Sea, Alaska. NMFS reviewed Shell's application and identified a number of issues requiring further clarification. After addressing comments from NMFS, Shell modified its application and submitted a revised application on December 10, 2009. However, after some additional discussions regarding certain activities, NMFS determined that a second revision to the application was warranted. The latest revised application was submitted to NMFS on March 18, 2010. NMFS carefully evaluated Shell's application, including their analyses, and determined that the application is complete and that it is appropriate to make the necessary preliminary determinations pursuant to the MMPA. The March 18, 2010, application is the one available for public comment (*see* **ADDRESSES**) and considered by NMFS for this proposed IHA.

Shell intends to drill two exploration wells at the Torpedo and Sivulliq prospects in Camden Bay, Beaufort Sea, Alaska, during the 2010 Arctic open-water season (July through October). Impacts to marine mammals may occur from noise produced by the drillship and supporting vessels and aircraft. Shell has requested an authorization to take 11 marine mammal species by Level B harassment. However, some of these species are not expected to be found in the activity area. Therefore, NMFS is proposing to authorize take of six marine mammal species, by Level B harassment, incidental to Shell's offshore exploration drilling in Camden Bay. These species include: beluga whale (*Delphinapterus leucas*); bowhead whale (*Balaena mysticetus*); gray whale (*Eschrichtius robustus*); bearded seal (*Erignathus barbatus*); ringed seal (*Phoca hispida*); and spotted seal (*P. largha*).

Description of the Specified Activity

Shell plans to conduct an offshore exploration drilling program on U.S. Department of the Interior, Minerals Management Service (MMS) Alaska OCS leases located north of Point Thomson near Camden Bay in the Beaufort Sea, Alaska, during the 2010 open-water season. During the 2010 drilling program, Shell plans to complete two exploration wells at two drill sites, one well each on the Torpedo (NR06–04 Flaxman Island lease block 6610, OCS–Y–1941 [Flaxman Island 6610]) and Sivulliq prospects (NR06–04 Flaxman Island lease block 6658, OCS–Y 1805 [Flaxman Island 6658]). *See* Figure 1–1 in Shell's application for the lease block and drill site locations *(see* **ADDRESSES**). All drilling is planned to be vertical.

Shell plans to drill the Torpedo prospect well first, followed by the Sivulliq well, unless adverse surface conditions or other factors dictate a reversal of drilling sequence. In that case, Shell will mobilize to the Sivulliq prospect and drill there first. The Torpedo H drill site is located 22 mi (35.4 km) from shore in water 120 ft (36.6 m) deep. The Sivulliq N drill site is located 16 mi (25.7 km) from shore with a water depth of 107 ft (32.6 m).

The ice reinforced drillship *Discoverer* will be used to drill the wells. The *Discoverer* is 514 ft (156.7 m) long with a maximum height (above keel) of 274 ft (83.7 m). Additional rig specifications for the *Discoverer* can be found in Attachment A of Shell's application (*see* **ADDRESSES**). While on location at the drill sites, the *Discoverer* will be affixed to the seafloor using eight 7-ton Stevpris anchors arranged in a radial array.

During the 2010 drilling season, the *Discoverer* will be attended by a minimum of seven vessels that will be used for ice-management, anchor handling, oil spill response (OSR), refueling, resupply, and servicing of the drilling operations. The ice-management vessels will consist of an icebreaker and an anchor handler. Table 1–1 in Shell's application provides a list of the support vessels that will be used during the drilling program, as well as information about trip frequency and duration for each vessel.

Re-supply between the drill sites and West Dock will use a coastwide qualified vessel. An ice-capable OSR barge (OSRB), with an associated tug, will be located nearby during the planned drilling program. The OSRB will be supported by a berthing vessel for the OSR crew. An OSR tanker also will be nearby for its storage capability of recovered liquids.

Shell's base plan is for two ice-management/anchor handling vessels, the M/V *Vladimir Ignatjuk* and the ice-management/anchor handling vessel *M/V Nordica* or similar vessels, to accompany the *Discoverer* traveling north of Dutch Harbor through the Bering Strait, after July 1, 2010, then through the Chukchi Sea, around Pt. Barrow, and east through the Alaskan Beaufort Sea, before arriving on location at the Torpedo "H" location on or about July 10, or Sivulliq "N" if adverse surface conditions or other factors dictate a reversal of drilling sequence. At the completion of the drilling season on or before October 31, 2010, one or two ice-management vessels, along with various support vessels, such as the OSR fleet, will accompany the *Discoverer* as it travels west through the Beaufort Sea, then south through the Chukchi Sea and the Bering Strait. Subject to ice conditions, alternate exit routes may be considered. Shell has planned a suspension of all operations beginning on August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The *Discoverer* and support vessels will leave the Camden Bay project area, will move to a location at or north of 71.25°N. latitude and at or west of 146.4°W. longitude and will return to resume activities after the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts conclude.

Shell will cease drilling on or before October 31, after which the *Discoverer* will exit the Alaskan Beaufort Sea. In total, Shell anticipates that the exploration drilling program will require approximately 74 drilling days, excluding weather delays, the shutdown period to accommodate the fall bowhead whale harvests at Kaktovik and Cross Island (Nuiqsut), or other operational delays. Shell assumes approximately 11 additional days will be needed for drillship mobilization, drillship moves between locations, and drillship demobilization.

Activities associated with the 2010 Beaufort Sea exploration drilling program include operation of the *Discoverer,* associated support vessels, crew change support and re-supply. The *Discoverer* will remain at the location of the designated exploration drill sites except when mobilizing and demobilizing to and from Camden Bay, transiting between drill sites, and temporarily moving off location if it is determined ice conditions require such a move to ensure the safety of personnel and/or the environment in accordance with Shell's Ice-management Plan (IMP). Ice-management vessels, anchor tenders, and OSR vessels will remain in close proximity to the drillship during drilling operations.

Shell recognizes that the drilling program is located in an area that is characterized by active sea ice movement, ice scouring, and storm surges. In anticipation of potential ice hazards that may be encountered, Shell has developed and will implement an IMP to ensure real-time ice and weather forecasting is conducted in order to identify conditions that might put operations at risk and will modify its activities accordingly. The IMP also contains ice threat classification levels depending on the time available to suspend drilling operations, secure the well, and escape from advancing hazardous ice. Real-time ice and weather forecasting will be available to operations personnel for planning purposes and to alert the fleet of impending hazardous ice and weather conditions. Ice and weather forecasting is provided by Shell's Ice and Weather Advisory Center. The center is continuously manned by experienced personnel, who rely on a number of data sources for ice forecasting and tracking, including:

• Radarsat and Envisat data—satellites with Synthetic Aperture Radar, providing all-weather imagery of ice conditions with very high resolution;

• Moderate Resolution Imaging Spectroradiometer—a satellite providing lower resolution visual and near infrared imagery;

• Aerial reconnaissance—provided by specially deployed fixed wing or rotary wing aircraft for confirmation of ice conditions and position;

• Reports from ice specialists on the ice-management and anchor handling vessels and from the ice observer on the drillship;

• Incidental ice data provided by commercial ships transiting the area; and

• Information from NOAA ice centers and the University of Colorado.

The ice-management/anchor handling vessels would manage the ice by deflecting any ice floes that could affect the *Discoverer* when it is drilling and would also handle the *Discoverer's* anchors during connection to and separation from the seafloor. The ice floe frequency and intensity are unpredictable and could range from no ice to ice sufficiently dense that the fleet has insufficient capacity to continue operating, and the *Discoverer* would need to disconnect from its anchors and move off site. If ice is present, ice-management activities may be necessary in early July and towards the end of operations in late October, but it is not expected to be needed throughout the proposed drilling season. Shell has indicated that when ice is present at the drill site, ice disturbance will be limited to the minimum needed to allow drilling to continue. First-year ice will be the type most likely to be encountered. The ice-management vessels will be tasked with managing the ice so that it will flow easily around and past the *Discoverer* without building up in front of it. This type of ice is managed by the ice-management vessel continually moving back and forth across the drift line, directly up-drift of the *Discoverer* and making turns at both ends. During ice-management, the vessel's propeller is rotating at approximately 15–20 percent of the vessel's propeller rotation capacity. Ice-management occurs with slow movements of the vessel using lower power and therefore slower propeller rotation speed (*i.e.,* lower cavitation), allowing for fewer repositions of the vessel, thereby reducing cavitation effects in the water. Occasionally, there may be multi-year ice ridges that would be managed at a much slower speed than that used to manage first-year ice. Shell has indicated that they do not have any intention of breaking ice with the ice-management vessels but, rather, intend to push it out of the area as described here. Should ice become so prevalent in the drilling area that it is difficult to continue operations without the breaking of ice, Shell has indicated that they would stop operations and move off site instead of breaking ice (S. Childs, Shell, 2010, pers. comm.). Shell has indicated that ice breaking would only be conducted if the ice poses an immediate safety hazard at the drill sites.

Crew change/re-supply vessels will transit to and from the drillship at the estimated frequency shown in Table 1–1 in Shell's application. Helicopters are planned to provide support for crew change, provision re-supply, and search-and-rescue operations during the drilling season. The aircraft operations will principally be based in Deadhorse, Alaska.

Potential impacts to marine mammals could occur from the noise produced by the drillship and its support vessels and aircraft. The drillship produces continuous noise into the marine environment. NMFS currently uses a threshold of 120 dB re 1 µPa (rms) for the onset of Level B harassment from continuous sound sources. Sound measurements from the *Discoverer* have not previously been conducted in the Arctic or elsewhere; however, sounds from a similar drillship, the *Northern Explorer II,* were measured at two different times and locations in the Beaufort Sea (Miles *et al.,* 1987; Greene, 1987a). The underwater received sound pressure level (SPL) in the 20–1,000 Hz band for drilling activity by the *Northern Explorer II,* including a nearby support vessel, was 134 dB re 1 µPa (rms) at 0.1 mi (0.2 km; Greene, 1987b). The back-propagated source levels (175 dB re 1 µPa at 1 m) from these measurements were used as a proxy for modeling the sounds likely to be produced by drilling activities from the *Discoverer.* NMFS has determined that the sound measurements for the *Northern Explorer II* constitute a good proxy for estimating sound radii for the *Discoverer.* Sound propagation measurements will be performed on the *Discoverer* in 2010 once on location near the Camden Bay drill sites in the Beaufort Sea. The results of those measurements will be used during the drilling season to implement proposed mitigation measures described later in this document (see the "Proposed Mitigation" section).

Although there will be several support vessels in the drilling operations area, NMFS considers the possibility of collisions with marine mammals highly unlikely. Once on location, the majority of the support vessels will remain in the area of the drillship throughout the 2010 drilling season and will not be making trips between the shorebase and the offshore vessels. Aircraft travel would be controlled by Federal Aviation Administration approved flight paths. Shell has agreed to a flight altitude of 1,500 ft (457 m; except during takeoffs and landings or during emergencies) for all non-marine mammal monitoring flights to minimize impacts on marine mammals. As the crew change/resupply activities are considered part of normal vessel traffic and are not anticipated to impact marine mammals in a manner that would rise to the level of taking, those activities are not considered further in this document. Additionally, ice-management activities are not anticipated to impact marine mammals in a manner that would rise to the level of taking. This is based on the fact that the propeller rotation *(i.e.,* cavitation) will be similar to that of vessels under normal operations and will not be used at 100 percent power as is the case in other situations rising to the level of taking *(e.g.,* thruster use for dynamic positioning at terminals).

Description of Marine Mammals in the Area of the Specified Activity

The Beaufort Sea supports a diverse assemblage of marine mammals, including: bowhead, gray, beluga, killer (*Orcinus orca*), minke (*Balaenoptera acutorostrata*), and humpback (*Megaptera novaeangliae*) whales; harbor porpoises (*Phocoena phocoena*); ringed, ribbon (*Histriophoca fasciata*), spotted, and bearded seals; polar bears (*Ursus maritimus*); and walruses (*Odobenus rosmarus divergens;* see Table 4–1 in Shell's application). The bowhead and humpback whales are listed as "endangered" under the Endangered Species Act (ESA) and as depleted under the MMPA. Certain stocks or populations of gray, beluga, and killer 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 proposed activity area. Additionally, the ribbon seal is considered a "species of concern" under the ESA, and the bearded and ringed seals are "candidate species" under the ESA, meaning they are currently being considered for listing. Both the walrus and the polar bear are managed by the U.S. Fish and Wildlife Service (USFWS) and are not considered further in this proposed IHA notice.

Of these species, six are expected to occur in the area of Shell's proposed operations. These species include: The bowhead, gray, and beluga whales and the ringed, spotted, and bearded seals. The marine mammal species that is likely to be encountered most widely (in space and time) throughout the period of the proposed drilling program is the ringed seal. Bowhead whales are also anticipated to occur in the proposed project area more frequently than the other cetacean species; however, their occurrence is not expected until later in the season. Where available, Shell used density estimates from peer-reviewed literature in the application. In cases where density estimates were not readily available in the peer-reviewed literature, Shell used other methods to derive the estimates. NMFS reviewed the density estimate descriptions and articles from which estimates were derived and requested additional information to better explain the density estimates presented by Shell in its application. This additional information was included in the revised IHA application. The explanation for those derivations and the actual density estimates are described later in this document (see the "Estimated Take by Incidental Harassment" section).

Other cetacean species that have been observed in the Beaufort Sea but are uncommon or rarely identified in the project area include harbor porpoise, narwhal, and killer, minke, humpback, and gray whales. These species could occur in the project area, but each of these species is uncommon or rare in the area and relatively few encounters with these species are expected during the exploration drilling program. The narwhal occurs in Canadian waters and occasionally in the Beaufort Sea, but it is rare there and is not expected to be encountered. There are scattered records of narwhal in Alaskan waters, including reports by subsistence hunters, where the species is considered extralimital (Reeves *et al.,* 2002). Point Barrow, Alaska, is the approximate northeastern extent of the harbor porpoise's regular range (Suydam and George, 1992), though there are extralimital records east to the mouth of the Mackenzie River in the Northwest Territories, Canada, and recent sightings in the Beaufort Sea in the vicinity of Prudhoe Bay during surveys in 2007 and 2008 (Christie *et al.,* 2009). Monnett and Treacy (2005) did not report any harbor porpoise sightings during aerial surveys in the Beaufort Sea from 2002 through 2004. Humpback and minke whales have recently been sighted in the Chukchi Sea but very rarely in the Beaufort Sea. Greene *et al.* (2007) reported and photographed a humpback whale cow/calf pair east of Barrow near Smith Bay in 2007, which is the first known occurrence of humpbacks in the Beaufort Sea. Savarese *et al.* (2009) reported one minke whale sighting in the Beaufort Sea in 2007 and 2008. Ribbon seals do not normally occur in the Beaufort Sea; however, two ribbon seal sightings were reported during vessel-based activities near Prudhoe Bay in 2008 (Savarese *et al.,* 2009). Due to the rarity of these species in the proposed project area and the remote chance they would be affected by Shell's proposed Beaufort Sea drilling activities, these species are not discussed further in this proposed IHA notice.

Shell's application contains information on the status, distribution, seasonal distribution, and abundance of each of the species under NMFS jurisdiction mentioned in this document. When reviewing the application, NMFS determined that the species descriptions provided by Shell correctly characterized the status, distribution, seasonal distribution, and abundance of each species. Please refer to the application for that information (*see* **ADDRESSES**). Additional information can also be found in the NMFS Stock Assessment Reports (SAR). The Alaska 2009 SAR is available at: *http://www.nmfs.noaa.gov/pr/pdfs/sars/ak2009.pdf.*

Potential Effects of the Specified Activity on Marine Mammals

Potential effects of Shell's proposed drilling program in Camden Bay on marine mammals would most likely be acoustic in nature. Petroleum development and associated activities introduce sound into the marine environment. Potential acoustic effects on marine mammals relate to sound produced by drilling activity, vessels, and aircraft. The potential effects of sound from the proposed exploratory drilling program might include one or more of the following: Tolerance; masking of natural sounds; behavioral disturbance; non-auditory physical effects; and, at least in theory, temporary or permanent hearing impairment (Richardson *et al.,* 1995a). However, for reasons discussed later in this document, it is unlikely that there would be any cases of temporary, or especially permanent, hearing impairment resulting from these activities. As outlined in previous NMFS documents, the effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson *et al.,* 1995a):

(1) The noise may be too weak to be heard at the location of the animal (*i.e.,* lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both);

(2) The noise may be audible but not strong enough to elicit any overt behavioral response;

(3) The noise may elicit reactions of variable conspicuousness and variable relevance to the well being of the marine mammal; these can range from temporary alert responses to active avoidance reactions such as vacating an area at least until the noise event ceases but potentially for longer periods of time;

(4) Upon repeated exposure, a marine mammal may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, infrequent, and unpredictable in occurrence, and associated with situations that a marine mammal perceives as a threat;

(5) Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of a marine mammal to hear natural sounds at similar frequencies, including calls from conspecifics, and underwater environmental sounds such as surf noise;

(6) If mammals remain in an area because it is important for feeding, breeding, or some other biologically important purpose even though there is chronic exposure to noise, it is possible that there could be noise-induced physiological stress; this might in turn have negative effects on the well-being or reproduction of the animals involved; and

(7) Very strong sounds have the potential to cause a temporary or permanent reduction in hearing sensitivity. In terrestrial mammals, and presumably marine mammals, received sound levels must far exceed the animal's hearing threshold for there to be any temporary threshold shift (TTS) in its hearing ability. For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound. Received sound levels must be even higher for there to be risk of permanent hearing impairment. In addition, intense acoustic or explosive events may cause trauma to tissues associated with organs vital for hearing, sound production, respiration and other functions. This trauma may include minor to severe hemorrhage.

Brief Background on Marine Mammal Hearing

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data, Southall *et al.* (2007) designate "functional hearing groups" for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. 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 22 kHz;
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;

- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, *Kogia,* the franciscana, and four species of cephalorhynchids): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz; and
- Pinnipeds in Water: Functional hearing is estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz.

As mentioned previously in this document, six marine mammal species (three pinniped and three cetacean species) are likely to occur in the proposed drilling area. Of the three cetacean species likely to occur in Shell's project area, two are classified as low frequency cetaceans (*i.e.,* bowhead and gray whales), and one is classified as a mid-frequency cetacean (*i.e.,* beluga whale) (Southall *et al.,* 2007).

Drilling Sounds

Exploratory drilling will be conducted from a vessel specifically designed for such operations in the Arctic. Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. Received sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene, 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene, 1987a).

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hz although tones up to 1,850 Hz were recorded by Greene (1987a) during drilling operations in the Beaufort Sea. At a range of 558 ft (170 m) the 20–1,000 Hz band level was 122–125 dB for the drillship *Explorer I.* Underwater sound levels were slightly higher (134 dB) during drilling activity from the *Northern Explorer II* at a range of 656 ft (200 m), although tones were only recorded below 600 Hz. Underwater sound measurements from the *Kulluk* at 0.62 mi (1 km) were higher (143 dB) than from the other two vessels. Shell used the measurements from the *Northern Explorer II* to model the various sound radii (which are discussed later in this document) for the *Discoverer.* Once on location at the drill sites in Camden Bay, Shell plans to take measurements of the *Discoverer* to quantify the absolute sound levels produced by drilling and to monitor their variations with time, distance, and direction from the drillship. Based on the similarities of the two drillships, NMFS has preliminarily determined that the radii produced by the *Discoverer* would be similar to those recorded for the *Northern Explorer II.*

Vessel Sounds

In addition to the drillship, various types of vessels will be used in support of the operations, including ice-management vessels, anchor handlers, and oil-spill response vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore, 1995; Blackwell and Greene, 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007 (*e.g.,* Aerts *et al.,* 2008; Hauser *et al.,* 2008; Brueggeman, 2009; Ireland *et al.,* 2009). For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB at distances ranging from approximately 1.5 to 2.3 mi (2.4 to 3.7 km) from various types of barges. MacDonald *et al.* (2008) estimated higher underwater SPLs from the seismic vessel *Gilavar* of 120 dB at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross, 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Richardson *et al.,* 1995a). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice.

Sound levels during ice-management activities would not be as intense as during icebreaking, and the resulting effects to marine species would be less significant in comparison. During ice-management, the vessel's propeller is rotating at approximately 15–20 percent of the vessel's propeller rotation capacity. Instead of actually breaking ice, during ice-management, the vessel redirects and repositions the ice by pushing it away from the direction of the drillship at slow speeds so that the ice floe does not slip past the vessel bow. Basically, ice-management occurs at slower speed, lower power, and slower propeller rotation speed (*i.e.,* lower cavitation), allowing for fewer repositions of the vessel, thereby reducing cavitation effects in the water than would occur during icebreaking. Once on location at the drill sites in Camden Bay, Shell plans to measure the sound levels produced by vessels operating in support of drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels.

Aircraft Sound

Helicopters may be used for personnel and equipment transport to and from the drillship. Under calm conditions, rotor and engine sounds are coupled into the water within a 26° cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26° area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in the shallow water.

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore, 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present.

Because of doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away.

Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Helicopters flying to and from the drillship will generally maintain straight-line routes at altitudes of at least 1,000 ft (305 m), thereby limiting the received levels at and below the surface.

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). 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.* (1995a) found that vessel noise does not seem to strongly affect pinnipeds that are already in the water. Richardson *et al.* (1995a) 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, and (Brueggeman et al., 1992; cited in Richardson *et al.*, 1995a) observed ringed seals hauled out on ice pans displaying short-term escape reactions when a ship approached within 0.25–0.5 mi (0.4–0.8 km).

Masking

The term "masking" refers to the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Masking effects of underwater sounds on marine mammal calls and other natural sounds are expected to be limited. For example, beluga whales primarily use high-frequency sounds to communicate and locate prey; therefore, masking by low-frequency sounds associated with drilling activities is not expected to occur (Gales, 1982, as cited in Shell, 2009). If the distance between communicating whales does not exceed their distance from the drilling activity, the likelihood of potential impacts from masking would be low (Gales, 1982, as cited in Shell, 2009). At distances greater than 660–1,300 ft (200–400 m), recorded sounds from drilling activities did not affect behavior of beluga whales, even though the sound energy level and frequency were such that it could be heard several kilometers away (Richardson *et al.*, 1995b). This exposure resulted in whales being deflected from the sound energy and changing behavior. These minor changes are not expected to affect the beluga whale population (Richardson *et al.*, 1991; Richard *et al.*, 1998). Brewer *et al.* (1993) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during drilling; however, the authors do not describe any behaviors that may have been exhibited by those animals. Please refer to the Arctic Multiple-Sale Draft Environmental Impact Statement (USDOI MMS, 2008), available on the Internet at: *http://www.mms.gov/alaska/ref/EIS%20EA/ArcticMultiSale_209/_DEIS.htm*, for more detailed information.

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

Although some masking by marine mammal species in the area may occur, the extent of the masking interference will depend on the spatial relationship of the animal and Shell's activity. If, as described later in this document, certain species avoid the proposed drilling locations, impacts from masking will be low.

Behavioral Disturbance Reactions

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (in both nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately pre-disposed to respond to certain sounds in certain ways; Southall *et al.*, 2007). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.*, calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.*, 2007). Individuals (of different age, gender, reproductive status, *etc.*) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.*, proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone.

Exposure of marine mammals to sound sources can result in (but is not limited to) no response or any of the following observable responses: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; avoidance; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death

(Southall *et al.*, 2007). On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.*, 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.*, 2007).

Detailed studies regarding responses to anthropogenic sound have been conducted on humpback, gray, and bowhead whales and ringed seals. Less detailed data are available for some other species of baleen whales, sperm whales, small toothed whales, and sea otters. The following sub-sections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed.

Baleen Whales—Baleen whale responses to pulsed sound (*e.g.*, seismic airguns) have been studied more thoroughly than responses to continuous sound (*e.g.,* drillships). 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).

Richardson *et al.* (1995b) reported changes in surfacing and respiration behavior and the occurrence of turns during surfacing in bowhead whales exposed to playback of underwater sound from drilling activities. These behavioral effects were localized and occurred at distances up to 1.2–2.5 mi (2–4 km). Some bowheads appeared to divert from their migratory path after exposure to projected icebreaker sounds. Other bowheads, however, tolerated projected icebreaker sound at levels 20 dB and more above ambient sound levels. The source level of the projected sound, however, was much less than that of an actual icebreaker, and reaction distances to actual icebreaking may be much greater than those reported here for projected sounds.

Brewer *et al.* (1993) and Hall *et al.* (1994) reported numerous sightings of marine mammals including bowhead whales in the vicinity of offshore drilling operations in the Beaufort Sea. One bowhead whale sighting was reported within approximately 1,312 ft (400 m) of a drilling vessel although other sightings were at much greater distances. Few bowheads were recorded near industrial activities by aerial observers, but observations by surface observers suggested that bowheads may have been closer to industrial activities than was suggested by results of aerial observations.

Richardson *et al.* (2008) reported a slight change in the distribution of bowhead whale calls in response to operational sounds on BP's Northstar Island. The southern edge of the call distribution ranged from 0.47 to 1.46 mi (0.76 to 2.35 km) farther offshore, apparently in response to industrial sound levels. This result, however, was only achieved after intensive statistical analyses, and it is not clear that this represented a biologically significant effect.

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). Restriction on aircraft altitude will be part of the proposed mitigation measures (described in the "Proposed Mitigation" section later in this document) during the proposed drilling activities, and overflights are likely to have little or no disturbance effects on baleen whales. Any disturbance that may occur would likely be temporary and localized.

Southall *et al.* (2007, Appendix C) reviewed a number of papers describing the responses of marine mammals to non-pulsed sound, such as that produced during exploratory drilling operations. In general, little or no response was observed in animals exposed at received levels from 90–120 dB re 1 μPa (rms). Probability of avoidance and other behavioral effects increased when received levels were from 120–160 dB re 1 μPa (rms). Some of the relevant reviews contained in Southall *et al.* (2007) are summarized next.

Baker *et al.* (1982) reported some avoidance by humpback whales to vessel noise when received levels were 110–120 dB (rms) and clear avoidance at 120–140 dB (sound measurements were not provided by Baker but were based on measurements of identical vessels by Miles and Malme, 1983).

Malme *et al.* (1983, 1984) used playbacks of sounds from helicopter overflight and drilling rigs and platforms to study behavioral effects on migrating gray whales. Received levels exceeding 120 dB induced avoidance reactions. Malme *et al.* (1984) calculated 10 percent, 50 percent, and 90 percent probabilities of gray whale avoidance reactions at received levels of 110, 120, and 130 dB, respectively. Malme *et al.* (1986) observed the behavior of feeding gray whales during four experimental playbacks of drilling sounds (50 to 315 Hz; 21-min overall duration and 10 percent duty cycle; source levels of 156–162 dB). In two cases for received levels of 100–110 dB, no behavioral reaction was observed. However, avoidance behavior was observed in two cases where received levels were 110–120 dB.

Richardson *et al.* (1990) performed 12 playback experiments in which bowhead whales in the Alaskan Arctic were exposed to drilling sounds. Whales generally did not respond to exposures in the 100 to 130 dB range, although there was some indication of minor behavioral changes in several instances.

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.

Biassoni *et al.* (2000) and Miller *et al.* (2000) reported behavioral observations for humpback whales exposed to a low-frequency sonar stimulus (160- to 330-Hz frequency band; 42-s tonal signal repeated every 6 min; source levels 170 to 200 dB) during playback experiments. Exposure to measured received levels ranging from 120 to 150 dB resulted in variability in humpback singing behavior. Croll *et al.* (2001) investigated responses of foraging fin and blue whales to the same low frequency active sonar stimulus off southern California. Playbacks and control intervals with no transmission were used to investigate behavior and distribution on time scales of several weeks and spatial scales of tens of kilometers. The general conclusion was that whales remained feeding within a region for which 12 to 30 percent of exposures exceeded 140 dB.

Frankel and Clark (1998) conducted playback experiments with wintering humpback whales using a single speaker producing a low-frequency "M-sequence" (sine wave with multiple-phase reversals) signal in the 60 to 90 Hz band with output of 172 dB at 1 m. For 11 playbacks, exposures were between 120 and 130 dB re 1 µPa (rms) and included sufficient information regarding individual responses. During eight of the trials, there were no measurable differences in tracks or bearings relative to control conditions, whereas on three occasions, whales either moved slightly away from (n = 1) or towards (n = 2) the playback speaker during exposure. The presence of the source vessel itself had a greater effect than did the M-sequence playback.

Finally, Nowacek *et al.* (2004) used controlled exposures to demonstrate behavioral reactions of northern right whales to various non-pulse sounds. Playback stimuli included ship noise, social sounds of conspecifics, and a complex, 18-min "alert" sound consisting of repetitions of three different artificial signals. Ten whales were tagged with calibrated instruments that measured received sound characteristics and concurrent animal movements in three dimensions. Five out of six exposed whales reacted strongly to alert signals at measured received levels between 130 and 150 dB (*i.e.*, ceased foraging and swam rapidly to the surface). Two of these individuals were not exposed to ship noise, and the other four were exposed to both stimuli. These whales reacted mildly to conspecific signals. Seven whales, including the four exposed to the alert stimulus, had no measurable response to either ship sounds or actual vessel noise.

Toothed Whales—Most toothed whales have the greatest hearing sensitivity at frequencies much higher than that of baleen whales and may be less responsive to low-frequency sound commonly associated with oil and gas industry exploratory drilling activities. Richardson *et al.* (1995b) reported that beluga whales did not show any apparent reaction to playback of underwater drilling sounds at distances greater than 656–1,312 ft (200–400 m). Reactions included slowing down, milling, or reversal of course after which the whales continued past the projector, sometimes within 164–328 ft (50–100 m). The authors concluded (based on a small sample size) that the playback of drilling sounds had no biologically significant effects on migration routes of beluga whales migrating through pack ice and along the seaward side of the nearshore lead east of Pt. Barrow in spring.

At least six of 17 groups of beluga whales appeared to alter their migration path in response to underwater playbacks of icebreaker sound (Richardson *et al.*, 1995b). Received levels from the icebreaker playback were estimated at 78–84 dB in the 1/3-octave band centered at 5,000 Hz, or 8–14 dB above ambient. If beluga whales reacted to an actual icebreaker at received levels of 80 dB, reactions would be expected to occur at distances on the order of 6.2 mi (10 km). Finley *et al.* (1990) also reported beluga avoidance of icebreaker activities in the Canadian High Arctic at distances of 22–31 mi (35–50 km). In addition to avoidance, changes in dive behavior and pod integrity were also noted. However, while the *Vladimir Ignatjuk* (an icebreaker) is anticipated to be one of the vessels attending the *Discoverer,* it will only be conducting ice-management activities (which were described in the "Description of the Specified Activity" section earlier in this document) and not physical breaking of ice. Thus, NMFS does not anticipate that marine mammals would exhibit the types of behavioral reactions as those noted in the aforementioned studies.

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.

In reviewing responses of cetaceans with best hearing in mid-frequency ranges, which includes toothed whales, Southall *et al.* (2007) reported that combined field and laboratory data for mid-frequency cetaceans exposed to non-pulse sounds did not lead to a clear conclusion about received levels coincident with various behavioral responses. In some settings, individuals in the field showed profound (significant) behavioral responses to exposures from 90 to 120 dB, while others failed to exhibit such responses for exposure to received levels from 120 to 150 dB. Contextual variables other than exposure received level, and probable species differences, are the likely reasons for this variability. Context, including the fact that captive subjects were often directly reinforced with food for tolerating noise exposure, may also explain why there was great disparity in results from field and laboratory conditions—exposures in captive settings generally exceeded 170 dB before inducing behavioral responses. A summary of some of the relevant material reviewed by Southall *et al.* (2007) is next.

LGL and Greeneridge (1986) and Finley *et al.* (1990) documented belugas and narwhals congregated near ice edges reacting to the approach and passage of ice-breaking ships. Beluga whales responded to oncoming vessels by (1) fleeing at speeds of up to 12.4 mi/hr (20 km/hr) from distances of 12.4–50 mi (20–80 km), (2) abandoning normal pod structure, and (3) modifying vocal behavior and/or emitting alarm calls. Narwhals, in contrast, generally demonstrated a "freeze" response, lying motionless or swimming slowly away (as far as 23 mi [37 km] down the ice edge), huddling in groups, and ceasing sound production. There was some evidence of habituation and reduced avoidance 2 to 3 days after onset.

The 1982 season observations by LGL and Greeneridge (1986) involved a single passage of an icebreaker with both ice-based and aerial measurements on June 28, 1982. Four groups of narwhals (n = 9 to 10, 7, 7, and 6) responded when the ship was 4 mi (6.4 km) away (received levels of approximately 100 dB in the 150- to 1,150-Hz band). At a later point, observers sighted belugas moving away from the source at more than 12.4 mi (20 km; received levels of approximately 90 dB in the 150- to 1,150-Hz band). The total number of animals observed fleeing was about 300, suggesting approximately 100 independent groups (of three individuals each). No whales were sighted the following day, but some were sighted on June 30, with ship noise audible at spectrum levels of approximately 55 dB/Hz (up to 4 kHz).

Observations during 1983 (LGL and Greeneridge, 1986) involved two ice-breaking ships with aerial survey and ice-based observations during seven sampling periods. Narwhals and belugas generally reacted at received levels ranging from 101 to 121 dB in the 20- to 1,000-Hz band and at a distance of up to 40.4 mi (65 km). Large numbers (100s) of beluga whales moved out of the area at higher received levels. As noise levels from icebreaking operations diminished, a total of 45 narwhals returned to the area and engaged in diving and foraging behavior. During the final sampling period, following an 8-h quiet interval, no reactions were seen from 28 narwhals and 17 belugas (at received levels ranging up to 115 dB).

The final season (1984) reported in LGL and Greeneridge (1986) involved aerial surveys before, during, and after the passage of two ice-breaking ships. During operations, no belugas and few narwhals were observed in an area approximately 16.8 mi (27 km) ahead of the vessels, and all whales sighted over 12.4–50 mi (20–80 km) from the ships were swimming strongly away. Additional observations confirmed the spatial extent of avoidance reactions to this sound source in this context.

Buckstaff (2004) reported elevated dolphin whistle rates with received levels from oncoming vessels in the 110 to 120 dB range in Sarasota Bay, Florida. These hearing thresholds were apparently lower than those reported by a researcher listening with towed hydrophones. Morisaka *et al.* (2005) compared whistles from three populations of Indo-Pacific bottlenose dolphins. One population was exposed to vessel noise with spectrum levels of approximately 85 dB/Hz in the 1- to 22-kHz band (broadband received levels approximately 128 dB) as opposed to approximately 65 dB/Hz in the same band (broadband received levels approximately 108 dB) for the other two sites. Dolphin whistles in the noisier environment had lower fundamental frequencies and less frequency modulation, suggesting a shift in sound parameters as a result of increased ambient noise.

Morton and Symonds (2002) used census data on killer whales in British Columbia to evaluate avoidance of non-pulse acoustic harassment devices (AHDs). Avoidance ranges were about 2.5 mi (4 km). Also, there was a dramatic reduction in the number of days "resident" killer whales were sighted during AHD-active periods compared to pre- and post-exposure periods and a nearby control site.

Awbrey and Stewart (1983) played back semi-submersible drillship sounds (source level: 163 dB) to belugas in Alaska. They reported avoidance reactions at 984 and 4,921 ft (300 and 1,500 m) and approach by groups at a distance of 2.2 mi (3.5 km; received levels approximately 110 to 145 dB over these ranges assuming a 15 log R transmission loss). Similarly, Richardson *et al.* (1990) played back drilling platform sounds (source level: 163 dB) to belugas in Alaska. They conducted aerial observations of eight individuals among approximately 100 spread over an area several hundred meters to several kilometers from the sound source and found no obvious reactions. Moderate changes in movement were noted for three groups swimming within 656 ft (200 m) of the sound projector.

Two studies deal with issues related to changes in marine mammal vocal behavior as a function of variable background noise levels. Foote *et al.* (2004) found increases in the duration of killer whale calls over the period 1977 to 2003, during which time vessel traffic in Puget Sound, and particularly whale-watching boats around the animals, increased dramatically. Scheifele *et al.* (2005) demonstrated that belugas in the St. Lawrence River increased the levels of their vocalizations as a function of the background noise level (the "Lombard Effect").

Several researchers conducting laboratory experiments on hearing and the effects of non-pulse sounds on hearing in mid-frequency cetaceans have reported concurrent behavioral responses. Nachtigall *et al.* (2003) reported that noise exposures up to 179 dB and 55-min duration affected the trained behaviors of a bottlenose dolphin participating in a TTS experiment. Finneran and Schlundt (2004) provided a detailed, comprehensive analysis of the behavioral responses of belugas and bottlenose dolphins to 1-s tones (received levels 160 to 202 dB) in the context of TTS experiments. Romano *et al.* (2004) investigated the physiological responses of a bottlenose dolphin and a beluga exposed to these tonal exposures and demonstrated a decrease in blood cortisol levels during a series of exposures between 130 and 201 dB. Collectively, the laboratory observations suggested the onset of a behavioral response at higher received levels than did field studies. The differences were likely related to the very different conditions and contextual variables between untrained, free-ranging individuals vs. laboratory subjects that were rewarded with food for tolerating noise exposure.

Pinnipeds—Pinnipeds generally seem to be less responsive to exposure to industrial sound than most cetaceans. Pinniped responses to underwater sound from some types of industrial activities such as seismic exploration appear to be temporary and localized (Harris *et al.*, 2001; Reiser *et al.*, 2009).

Blackwell *et al.* (2004) reported little or no reaction of ringed seals in response to pile-driving activities during construction of a man-made island in the Beaufort Sea. Ringed seals were observed swimming as close as 151 ft (46 m) from the island and may have been habituated to the sounds which were likely audible at distances <9,842 ft (3,000 m) underwater and 0.3 mi (0.5 km) in air. Moulton *et al.* (2003) reported that ringed seal densities on ice in the vicinity of a man-made island in the Beaufort Sea did not change significantly before and after construction and drilling activities.

Southall *et al.* (2007) reviewed literature describing responses of pinnipeds to non-pulsed sound and reported that the limited data suggest exposures between approximately 90 and 140 dB generally do not appear to induce strong behavioral responses in pinnipeds exposed to non-pulse sounds in water; no data exist regarding exposures at higher levels. It is important to note that among these studies, there are some apparent differences in responses between field and laboratory conditions. In contrast to the mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field. Again, contextual issues are the likely cause of this difference.

Jacobs and Terhune (2002) observed harbor seal reactions to AHDs (source level in this study was 172 dB) deployed around aquaculture sites. Seals were generally unresponsive to sounds from the AHDs. During two specific events, individuals came within 141 and 144 ft (43 and 44 m) of active AHDs and failed to demonstrate any measurable behavioral response; estimated received levels based on the measures given were approximately 120 to 130 dB.

Costa *et al.* (2003) measured received noise levels from an Acoustic Thermometry of Ocean Climate (ATOC) program sound source off northern California using acoustic data loggers placed on translocated elephant seals. Subjects were captured on land, transported to sea, instrumented with archival acoustic tags, and released such that their transit would lead them near an active ATOC source (at 939-m depth; 75-Hz signal with 37.5-Hz bandwidth; 195 dB maximum source level, ramped up from 165 dB over 20 min) on their return to a haul-out site. Received exposure levels of the ATOC source for experimental subjects averaged 128 dB (range 118 to 137) in the 60- to 90-Hz band. None of the instrumented animals terminated dives or radically altered behavior upon exposure, but some statistically significant changes in diving parameters were documented in nine individuals. Translocated northern elephant seals exposed to this particular non-pulse source began to demonstrate subtle behavioral changes at exposure to received levels of approximately 120 to 140 dB.

Kastelein *et al.* (2006) exposed nine captive harbor seals in an approximately 82 × 98 ft (25 × 30 m) enclosure to non-pulse sounds used in underwater data communication systems (similar to acoustic modems). Test signals were frequency modulated tones, sweeps, and bands of noise with fundamental frequencies between 8 and 16 kHz; 128 to 130 [± 3] dB source levels; 1- to 2-s duration [60–80 percent duty cycle]; or 100 percent duty cycle. They recorded seal positions and the mean number of individual surfacing behaviors during control periods (no exposure), before exposure, and in 15-min experimental sessions (n = 7 exposures for each sound type). Seals generally swam away from each source at received levels of approximately 107 dB, avoiding it by approximately 16 ft (5 m), although they did not haul out of the water or change surfacing behavior. Seal reactions did not appear to wane over repeated exposure (*i.e.,* there was no obvious habituation), and the colony of seals generally returned to baseline conditions following exposure. The seals were not reinforced with food for remaining in the sound field.

Hearing Impairment and Other Physiological Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. Non-auditory physiological effects might also 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. It is possible that some marine mammal species (*i.e.,* beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, as discussed later in this document, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to industrial sound sources, and beaked whales do not occur in the proposed activity area. The following subsections discuss in somewhat more detail the possibilities of TTS, permanent threshold shift (PTS), and non-auditory physiological effects.

TTS—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound.

For toothed whales exposed to single, short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran *et al.,* 2002, 2005). Given the available data, the received level of a single seismic pulse (with no frequency weighting) might need to be approximately 186 dB re 1 $\mu Pa^2 \cdot s$ (*i.e.,* 186 dB sound exposure level [SEL]) in order to produce brief, mild TTS. Exposure to several strong seismic pulses that each have received levels near 175–180 dB SEL might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Given that the SPL is approximately 10–15 dB higher than the SEL value for the same pulse, an odontocete would need to be exposed to a sound level of 190 dB re 1 μPa (rms) in order to incur TTS.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. Marine mammals can hear sounds at varying frequency levels. However, sounds that are produced in the frequency range at which an animal hears the best do not need to be as loud as sounds in less functional frequencies to be detected by the animal. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison, 2004), meaning that baleen whales require sounds to be louder (i.e., higher dB levels) than odontocetes in the frequency ranges at which each group hears the best. From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales. Since current NMFS practice assumes the same thresholds for the onset of hearing impairment in both odontocetes and mysticetes, the threshold is likely conservative for mysticetes.

In free-ranging pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. However, systematic TTS studies on captive pinnipeds have been conducted (Bowles *et al.,* 1999; Kastak *et al.,* 1999, 2005, 2007; Schusterman *et al.,* 2000; Finneran *et al.,* 2003; Southall *et al.,* 2007). Kastak *et al.* (1999) reported TTS of approximately 4–5 dB in three species of pinnipeds (harbor seal, Californian sea lion, and northern elephant seal) after underwater exposure for approximately 20 minutes to noise with frequencies ranging from 100 Hz to 2,000 Hz at received levels 60–75 dB above hearing threshold. This approach allowed similar effective exposure conditions to each of the subjects, but resulted in variable absolute exposure values depending on subject and test frequency. Recovery to near baseline levels was reported within 24 hours of noise exposure (Kastak *et al.,* 1999). Kastak *et al.* (2005) followed up on their previous work using higher sensitive levels and longer exposure times (up to 50-min) and corroborated their previous findings. The sound exposures necessary to cause slight threshold shifts were also determined for two California sea lions and a juvenile elephant seal exposed to underwater sound for similar duration. The sound level necessary to cause TTS in pinnipeds depends on exposure duration, as in other mammals; with longer exposure, the level necessary to elicit TTS is reduced (Schusterman *et al.,* 2000; Kastak *et al.,* 2005, 2007). For very short exposures (e.g., to a single sound pulse), the level necessary to cause TTS is very high (Finneran *et al.,* 2003). For pinnipeds exposed to in-air sounds, auditory fatigue has been measured in response to single pulses and to non-pulse noise (Southall *et al.,* 2007), although high exposure levels were required to induce TTS-onset (SEL: 129 dB re: 20 $\mu Pa^2 \cdot s$; Bowles *et al.,* unpub. data).

NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 µPa (rms). The established 180- and 190-dB re 1 µPa (rms) criteria are not considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. Based on the summary provided here and the fact that modeling indicates the back-propagated source level for the drillship to be 175 dB re 1 µPa at 1 m, TTS is not expected to occur in any marine mammal species that may occur in the proposed drilling area since the source level will not reach levels thought to induce even mild TTS.

PTS—When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges.

There is no specific evidence that exposure to underwater industrial sound associated with oil exploration can cause PTS in any marine mammal (*see* Southall *et al.,* 2007). However, given the possibility that mammals might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to such activities might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. Relationships between TTS and PTS thresholds have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS.

It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause PTS during the proposed exploratory drilling program. As mentioned previously in this document, the source levels of the drillship are not considered strong enough to cause even slight TTS. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. In fact, based on the modeled source levels for the drillship, the levels immediately adjacent to the drillship may not be sufficient to induce PTS, even if the animals remain in the immediate vicinity of the activity. The modeled source level from a similar drillship (*i.e.,* the *Northern Explorer II*) suggests that marine mammals located immediately adjacent to a drillship such as the *Discoverer* would likely not be exposed to received sound levels of a magnitude strong enough to induce PTS, even if the animals remain in the immediate vicinity of the proposed activity location for a prolonged period of time.

Non-auditory Physiological Effects—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, and other types of organ or tissue damage. If any such effects do occur, they probably would be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is doubtful that any single marine mammal would be exposed to strong sounds for sufficiently long that significant physiological stress would develop.

Until recently, it was assumed that diving marine mammals are not subject to the bends or air embolism. This possibility was first explored at a workshop (Gentry [ed.], 2002) held to discuss whether the stranding of beaked whales in the Bahamas in 2000 (Balcomb and Claridge, 2001; NOAA and USN, 2001) might have been related to bubble formation in tissues caused by exposure to noise from naval sonar. However, the opinions were inconclusive. Jepson *et al.* (2003) first suggested a possible link between mid-frequency sonar activity and acute and chronic tissue damage that results from the formation in vivo of gas bubbles, based on the beaked whale stranding in the Canary Islands in 2002 during naval exercises. Fernandez *et al.* (2005a) showed those beaked whales did indeed have gas bubble-associated lesions as well as fat embolisms. Fernandez *et al.* (2005b) also found evidence of fat embolism in three beaked whales that stranded 62 mi (100 km) north of the Canaries in 2004 during naval exercises. Examinations of several other stranded species have also revealed evidence of gas and fat embolisms (Arbelo *et al.,* 2005; Jepson *et al.,* 2005a; Mendez *et al.,* 2005). Most of the afflicted species were deep divers. There is speculation that gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds or if sound in the environment causes the destabilization of existing bubble nuclei (Potter, 2004; Arbelo *et al.,* 2005; Fernandez *et al.,* 2005a; Jepson *et al.,* 2005b). Even if gas and fat embolisms can occur during exposure to mid-frequency sonar, there is no evidence that that type of effect occurs in response to the types of sound produced during the proposed exploratory activities. Also, most evidence for such effects has been in beaked whales, which do not occur in the proposed survey area.

The low levels of continuous sound that will be produced by the drillship are not expected to cause such effects. Additionally, marine mammals that show behavioral avoidance of the proposed activities, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur auditory impairment or other physical effects.

Stranding and Mortality

Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.,* 1993; Ketten, 1995). Underwater sound from drilling and support activities is less energetic and has slower rise times, and there is no proof that they can cause serious injury, death, or stranding. However, the association of mass strandings of beaked whales with naval exercises and, in one case, a Lamont-Doherty Earth Observatory seismic survey, has raised the possibility that beaked whales exposed to strong pulsed sounds may be especially susceptible to injury and/or behavioral reactions that can lead to stranding. The potential for stranding to result from exposure to strong pulsed sound suggests that caution be used when exposing marine mammals to pulsed or other underwater sound. Most of the stranding events associated with exposure of marine mammals to pulsed sound however, have involved beaked whales which do not occur in the proposed area. Additionally, the sound produced from the proposed activities will be at much lower levels than those reported during stranding events, as the source levels of the drillship are much lower than those other sources. Pulsed sounds, such as those produced by seismic airgun arrays, are transient and have rapid rise times, whereas the non-impulsive, continuous sounds produced by the drillship to be used by Shell do not have rapid rise time. Rise time is the fluctuation in sound levels of the source. The type of sound that would be produced during the proposed drilling program will be constant and will not exhibit any sudden fluctuations or changes.

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

Anticipated Effects on Habitat

The primary potential impacts to marine mammals and other marine species are associated with elevated sound levels produced by the exploratory drilling program. However, other potential impacts to the surrounding habitat from physical disturbance are also possible.

Potential Impacts From Seafloor Disturbance

There is a possibility of some seafloor disturbance or temporary increased turbidity in the seabed sediments during anchoring and excavation of the mudline cellars (MLCs). The amount and duration of disturbed or turbid conditions will depend on sediment material and consolidation of specific activity.

Both the anchor and anchor chain will disturb sediments and create an "anchor scar," which is a depression in the seafloor caused by the anchor embedding. The anchor scar is a depression with ridges of displaced sediment, and the area of disturbance will often be greater than the size of the anchor itself because the anchor is dragged along the seafloor until it takes hold and sets. The drilling units will be stabilized and held in place with a system of eight 7,000 kg anchors during operations, which are designed to embed into the seafloor. Each anchor may impact an area of 775 ft^2 (72 m^2) of the seafloor. Minimum impact estimates from each well or mooring by the *Discoverer* is 9,300 ft^2 (864 m^2) of seafloor. This estimate assumes that the anchors are set only once and not moved by outside forces such as sea current. However, based on the vast size of the Beaufort Sea, the area of disturbance is not anticipated to adversely affect marine mammal use of the area.

Once the drillship ends operation, the anchors will be retrieved. Over time, the anchor scars will be filled through natural movement of sediment. The duration of the scars depends upon the energy of the system, water depth, ice scour, and sediment type. Anchor scars were visible under low energy conditions in the North Sea for 5–10 years after retrieval. Scars typically do not form or persist in sandy mud or sand sediments (such as those found in the Beaufort Sea) but may last for 9 years in hard clays (Centaur Associates Inc., 1984). The energy regime plus possible effects of ice gouge in the Beaufort Sea suggest that anchor scars would be refilled faster than in the North Sea.

Vessel mooring and MLC construction would result in increased suspended sediment in the water column that could result in lethal effects on some zooplankton (food source for baleen whales). However, compared to the overall population of zooplankton and the localized nature of effects, any mortality that may occur would not be considered significant. Due to fast regeneration periods of zooplankton, populations are expected to recover quickly.

Impacts on fish resulting from suspended sediments would be dependent upon the life stage of the fish (*e.g.,* eggs, larvae, juveniles, or adults), the concentration of the suspended sediments, the type of sediment, and the duration of exposure (IMG Golder, 2004). Eggs and larvae have been found to exhibit greater sensitivity to suspended sediments (Wilber and Clarke, 2001) and other stresses, which is thought to be related to their relative lack of motility (Auld and Schubel, 1978). Sedimentation could affect fish by causing egg morbidity of demersal fish feeding near or on the ocean floor (Wilber and Clarke, 2001). Surficial membranes are especially susceptible to abrasion (Cairns and Scheier, 1968). However, most of the abundant Beaufort Sea fish species with demersal eggs spawn under the ice in the winter well before MLC excavation would occur. Exposure of pelagic eggs would be much shorter as they move with ocean currents (Wilber and Clarke, 2001).

Suspended sediments, resulting from vessel mooring and MLC excavation, are not expected to result in permanent damage to habitats used by the marine mammal species in the proposed project area or on the food sources that they utilize. Rather, NMFS considers that such impacts will be temporary in nature and concentrated in the areas directly surrounding vessel mooring and MLC excavation activities—areas which are very small relative to the overall Beaufort Sea region.

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.

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). In general, fish react more strongly to pulses of sound rather than a continuous signal (Blaxter *et al.,* 1981), such as the type of sound that will be produced by the drillship, and a quicker alarm response is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level.

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). (Based on measurements from the *Northern Explorer II,* the 160 dB radius for the *Discoverer* was modeled by JASCO to be approximately 115 ft [35 m]; therefore, fish would need to be in close proximity to the drillship for the noise to be audible). In calm weather, ambient noise levels in audible parts of the spectrum lie between 60 dB to 100 dB.

Sound will also occur in the marine environment from the various support vessels. Reported source levels for vessels during ice-management have ranged from 175 dB to 185 dB (Brewer *et al.,* 1993, Hall *et al.,* 1994). However, ice-management activities are not expected to be necessary throughout the entire drilling season, so impacts from that activity would occur less frequently than sound from the drillship. Sound pressures generated while drilling have been measured during past exploration in the Beaufort and Chukchi seas. Sounds generated by drilling and ice-management are generally low frequency and within the frequency range detectable by most fish.

Based on a sound level of approximately 140 dB, there may be some avoidance by fish of the area near the drillship while drilling, around ice-management vessels in transit and during ice-management, and around other support and supply vessels when underway. Any reactions by fish to these sounds will last only minutes (Mitson and Knudsen, 2003; Ona *et al.,* 2007) longer than the vessel is operating at that location or the drillship is drilling. Any potential reactions by fish would be limited to a relatively small area within about 0.21 mi (0.34 km) of the drillship during drilling (JASCO, 2007). Avoidance by some fish or fish species could occur within portions of this area. No important spawning habitats are known to occur at or near the drilling locations. Additionally, impacts to fish as a prey species for odontocetes and seals are expected to be minor.

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, and others feed intermittently during their westward migration in September and October (Richardson and Thomson [eds.], 2002; Lowry *et al.,* 2004). 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. A reaction by zooplankton to sounds produced by the exploratory drilling program 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 due to the low energy sounds produced by the drillship. 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.

Aerial surveys in recent years have sighted bowhead whales feeding in Camden Bay on their westward migration through the Beaufort Sea. Individuals feeding in the Camden Bay area at the beginning of the migration (*i.e.,* approximately late August or early September) are not expected to be impacted by Shell's proposed drilling program, primarily because of Shell's proposal to suspend operations and depart the area on August 25 and not return until the close of the Kaktovik and Nuiqsut (Cross Island) hunts, which typically ends around mid- to late September (see the "*Plan of Cooperation (POC)*" subsection later in this document for more details). If other individual bowheads stop to feed in the Camden Bay area after Shell resumes drilling operations in mid- to late September, they may potentially be exposed to sounds from the drillship. However, injury to the bowhead whales is not anticipated, as the source level of the drillship is not loud enough to cause even mild TTS, as discussed earlier in this document. As mentioned earlier in this document, some bowhead whales have demonstrated avoidance behavior in areas of industrial sound (*e.g.,* Richardson *et al.,* 1999) and some have continued to feed even in the presence of industrial activities (Richardson, 2004). However, Camden Bay is one of a few feeding locations for bowhead whales in the Beaufort Sea. Also, as discussed previously, drilling operations are not expected to adversely affect bowhead whale prey species or preclude bowhead whales from obtaining sufficient food resources along their traditional migratory path.

Potential Impacts From Drillship Presence

The *Discoverer* is 514 ft (156.7 m) long. If an animal's swim path is directly perpendicular to the drillship, the animal will need to swim around the ship in order to pass through the area. The length of the drillship (approximately one and a half football fields) is not significant enough to cause a large-scale diversion from the animals' normal swim and migratory paths. Additionally, the eastward spring bowhead whale migration will occur prior to the beginning of Shell's proposed exploratory drilling program. The westward fall bowhead whale migration begins in late August/early September and lasts through October. As discussed throughout this document, Shell plans to suspend all operations on August 25, move the drillship and all support vessels out of the area to a location north and west of the well sites, and will not resume drilling activities until the close of the Kaktovik and Nuiqsut bowhead subsistence hunts. This will reduce the amount of time that the *Discoverer* may impede the bowheads' normal swim and migratory paths as they move through Camden Bay. Moreover, any deflection of bowhead whales or other marine mammal species due to the physical presence of the drillship or its support vessels would be very minor. The drillship's physical footprint is small relative to the size of the geographic region it will occupy and will likely not cause marine mammals to deflect greatly from their typical migratory route. Also, even if animals may deflect because of the presence of the drillship, the Beaufort Sea's migratory corridor is much larger in size than the length of the drillship (many dozens of miles vs. less than two football fields), and animals would have other means of passage around the drillship. In sum, the physical presence of the drillship is not likely to cause a significant deflection to migrating marine mammals.

Potential Impacts From Ice Management

Ice-management activities include the physical pushing or moving of ice to create more open-water in the proposed drilling area and to prevent ice floes from striking the drillship. Ringed, bearded, and spotted seals (along with the ribbon seal and walrus) are dependent on sea ice for at least part of their life history. Sea ice is important for life functions such as resting, breeding, and molting. These species are dependent on two different types of ice: Pack ice and landfast ice. Should ice-management activities be necessary during the proposed drilling program, Shell would only manage pack ice in either early to mid-July or mid- to late October. Landfast ice would not be present during Shell's proposed operations.

The ringed seal is the most common pinniped species in the proposed project area. While ringed seals use ice year-round, they do not construct lairs for pupping until late winter/early spring on the landfast ice. Therefore, since Shell plans to conclude drilling on October 31, Shell's activities would not impact ringed seal lairs or habitat needed for breeding and pupping in the Camden Bay area. Ringed seals can be found on the pack ice surface in the late spring and early summer in the Beaufort Sea, the latter part of which may overlap with the start of Shell's proposed drilling activities. If an ice floe is pushed into one that contains hauled out seals, the animals may become startled and enter the water when the two ice floes collide. Bearded seals breed in the Bering and Chukchi Seas, as the Beaufort Sea provides less suitable habitat for the species. Spotted seals are even less common in the Camden Bay area. This species does not breed in the Beaufort Sea. Therefore, ice used by bearded and spotted seals needed for life functions such as breeding and molting would not be impacted as a result of Shell's drilling program since these life functions do not occur in the proposed project area.

For ringed seals, ice-management would occur during a time when life functions such as breeding, pupping, and molting do not occur in the proposed activity area. Additionally, these life functions normally occur on landfast ice, which will not be impacted by Shell's activity.

In conclusion, NMFS has preliminarily determined that Shell's proposed exploration drilling program in Camden Bay, Beaufort Sea, Alaska, is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or on the food sources that they utilize.

Proposed Mitigation

In order to issue an incidental take authorization (ITA) under Sections 101(a)(5)(A) and (D) of the MMPA, NMFS must, where applicable, 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).

Mitigation Measures Proposed in Shell's IHA Application

Shell submitted a Marine Mammal Monitoring and Mitigation Plan (4MP) as part of its application (Attachment B; *see* **ADDRESSES**). Shell's planned offshore drilling program incorporates both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures have been described in the IHA and LOA applications submitted to NMFS and USFWS, respectively, and are summarized here. Survey design features include:

- Timing and locating drilling and support activities to avoid interference with the annual fall bowhead whale hunts from Kaktovik, Nuiqsut (Cross Island), and Barrow;
- Identifying transit routes and timing to avoid other subsistence use areas and communicating with coastal communities before operating in or passing through these areas; and
- Conducting pre-season sound propagation modeling to establish the appropriate safety and behavioral radii.

Shell indicates that the potential disturbance of marine mammals during operations will be minimized further through the implementation of several ship-based mitigation measures, which include establishing and monitoring safety and disturbance zones and shutting down activities for a portion of the open-water season.

Safety radii for marine mammals around sound sources are customarily defined as the distances within which received sound levels are greater than or equal to 180 dB re 1 μPa (rms) for cetaceans and greater than or equal to 190 dB re 1 μPa (rms) for pinnipeds. These safety criteria are based on an assumption that sounds at lower received levels will not injure these animals or impair their hearing abilities, but that higher received levels might have such effects. It should be understood that marine mammals inside these safety zones will not necessarily be injured, seriously injured, or killed, as the received sound thresholds which determine these zones were established prior to the current understanding that significantly higher levels of sound would be required before injury, serious injury, or mortality could occur (*see* Southall *et al.,* 2007). With respect to Level B harassment, NMFS' practice has been to apply the 120 dB re 1 μPa (rms) received level threshold for underwater continuous sound levels.

Initial safety and behavioral radii for the sound levels produced by the drilling activities have been modeled. These radii will be used for mitigation purposes, should they be necessary, until direct measurements are available early during the exploration activities. However, it is not anticipated that source levels from the *Discoverer* will reach the 180- or 190-dB (rms) levels.

Sounds from the *Discoverer* have not previously been measured in the Arctic or elsewhere, but sounds from a similar drillship, *Explorer II,* were measured in the Beaufort Sea (Greene, 1987; Miles *et al.,* 1987). The underwater received SPL in the 20 to 1,000 Hz band for drilling activity by the *Explorer II,* including a nearby support vessel, was 134 dB re 1 μPa (rms) at 0.1 mi (0.2 km; Greene 1987). The back-propagated source levels (175 dB re 1 μPa at 1 m) from these measurements were used as a proxy for modeling the sounds likely to be produced by drilling activities from the *Discoverer.* Based on the models, source levels from drilling are not expected to reach the 180 dB rms level and are expected to fall below 160 dB rms at 115 ft (35 m) from the drillship. The 120 dB rms radius is expected to be 3 mi (4.9 km) from the drillship. These estimated source measurements were used to model the expected sounds produced at the exploratory well sites by the *Discoverer.*

Based on the best available scientific literature, the source levels noted above for exploration drilling are not high enough to cause a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. Consequently, Shell believes that mitigation as described for seismic activities including ramp ups, power downs, and shutdowns should not be necessary for drilling activities. NMFS has also preliminarily determined that these types of mitigation measures, traditionally required for seismic survey operations, are not practical or necessary for this proposed drilling activity. Seismic airgun arrays can be turned on slowly (*i.e.,* only turning on one or some guns at a time) and powered down quickly. The types of sound sources used for exploratory drilling have different properties and are unable to be "powered down" like airgun arrays or shutdown instantaneously without posing other risks. However, Shell plans to use marine mammal observers (MMOs) onboard the drillship and the various support vessels to monitor marine mammals and their responses to industry activities and to initiate mitigation measures should in-field measurements of the operations indicate that such measures are necessary. Additional details on the MMO program are described in the "Proposed Monitoring and Reporting" section found later in this document.

Drilling sounds are expected to vary significantly with time due to variations in the level of operations and the different types of equipment used at different times onboard the drillship. Once on location in Camden Bay, Shell will conduct sound source verification (SSV) tests to establish safety zones for the previously mentioned sound level criteria. The objectives of the SSV tests are: (1) To quantify the absolute sound levels produced by drilling and to monitor their variations with time, distance, and direction from the drillship; and (2) to measure the sound levels produced by vessels operating in support of drilling operations, which include crew change vessels, tugs, ice-management vessels, and spill response vessels. The methodology for conducting the SSV tests is fully described in Shell's 4MP (*see* **ADDRESSES**). Please refer to that document for further details. Upon completion of the SSV tests, the new radii will be established and monitored, and mitigation measures will be implemented in accordance with Shell's 4MP.

Additional mitigation measures proposed by Shell include: (1) Reducing speed and/or changing course if a marine mammal is sighted from a vessel in transit (NMFS has proposed a specific distance in the next subsection); (2) resuming full activity (*e.g.,* full support vessel speed) only after marine mammals are confirmed to be outside the safety zone; (3) implementing flight restrictions prohibiting aircraft from flying below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations); and (4) keeping vessels anchored when approached by marine mammals to avoid the potential for avoidance reactions by such animals.

Shell has also proposed additional mitigation measures to ensure no unmitigable adverse impact on the availability of affected species or stocks for taking for subsistence uses. Those measures are described in the "Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses" section found later in this document.

Additional Mitigation Measures Proposed by NMFS

In addition to the mitigation measures proposed in Shell's IHA application, NMFS proposes the following measures be included in the IHA, if issued, in order to ensure the least practicable impact on the affected species or stocks:

(1) All vessels should reduce speed when within 300 yards (274 m) of whales. The reduction in speed will vary based on the situation but must be sufficient to avoid interfering with the whales. Those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group;

(2) Avoid multiple changes in direction and speed when within 300 yards (274 m) of whales; and

(3) When weather conditions require, such as when visibility drops, support vessels must reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to whales.

Mitigation Conclusions

NMFS has carefully evaluated the applicant'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 measure is expected to minimize adverse impacts to marine mammals;
- The proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and
- The practicability of the measure for applicant implementation.

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 mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must, where applicable, 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.

Monitoring Measures Proposed in Shell's IHA Application

The monitoring plan proposed by Shell can be found in the 4MP (Attachment B of Shell's application; *see* **ADDRESSES**). The plan may be modified or supplemented based on comments or new information received from the public during the public comment period or from the peer review panel (*see* the "Monitoring Plan Peer Review" section later in this document). A summary of the primary components of the plan follows.

(1) Vessel-Based MMOs

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of drilling operations. MMOs will monitor the occurrence and behavior of marine mammals near the drillship during all daylight periods during operation and during most daylight periods when drilling operations are not occurring. MMO duties will include watching for and identifying marine mammals, recording their numbers, distances, and reactions to the drilling operations. A sufficient number of MMOs will be required onboard each vessel to meeting the following criteria: (1) 100 percent monitoring coverage during all periods of drilling operations in daylight; (2) maximum of 4 consecutive hours on watch per MMO; and (3) maximum of 12 hours of watch time per day per MMO. Shell anticipates that there will be provision for crew rotation at least every 6 weeks to avoid observer fatigue.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring projects. Resumes for those individuals will be provided to NMFS so that NMFS can review and accept their qualifications. Inupiat observers will be experienced in the region, familiar with the marine mammals of the area, and complete a NMFS approved observer training course designed to familiarize individuals with monitoring and data collection procedures. A MMO handbook, adapted for the specifics of the planned Shell drilling program, will be prepared and distributed beforehand to all MMOs.

MMOs will watch for marine mammals from the best available vantage point on the drillship and support vessels. MMOs will scan systematically with the unaided eye and 7 x 50 reticle binoculars, supplemented with 20 x 60 image-stabilized Zeiss Binoculars or Fujinon 25 x 150 "Big-eye" binoculars and night-vision equipment when needed. Personnel on the bridge will assist the MMOs in watching for marine mammals.

Information to be recorded by marine mammal observers will include the same types of information that were recorded during recent monitoring programs associated with industry activity in the Arctic (*e.g.,* Ireland *et al.,* 2009). When a mammal sighting is made, the following information about the sighting will be recorded:

(A) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from the MMO, apparent reaction to activities (*e.g.,* none, avoidance, approach, paralleling, *etc.*), closest point of approach, and behavioral pace;

(B) Time, location, speed, activity of the vessel, sea state, ice cover, visibility, and sun glare; and

(C) The positions of other vessel(s) in the vicinity of the MMO location.

The ship's position, speed of support vessels, and water temperature, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. MMOs may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that a Class 1 eye-safe device was not able to measure distances to seals more than about 230 ft (70 m) away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 1968 ft (600 m)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20 percent when given immediate feedback about actual distances during training.

(2) Aerial Survey Program

Shell proposes to conduct an aerial survey program in support of the drilling program in the Beaufort Sea during the summer and fall of 2010. Shell's objectives for this program include:

(A) To advise operating vessels as to the presence of marine mammals (primarily cetaceans) in the general area of operation;

(B) To collect and report data on the distribution, numbers, movement and behavior of marine mammals near the drilling operations with special emphasis on migrating bowhead whales;

(C) To support regulatory reporting related to the estimation of impacts of drilling operations on marine mammals;

(D) To investigate potential deflection of bowhead whales during migration by documenting how far east of drilling operations a deflection may occur and where whales return to normal migration patterns west of the operations; and

(E) To monitor the accessibility of bowhead whales to Inupiat hunters.

Aerial survey flights will begin 5 to 7 days before operations at the exploration well sites get underway. Surveys will be flown daily throughout drilling operations, weather and flight conditions permitting, and continued for 5 to 7 days after all activities at the site have ended.

The aerial survey procedures will be generally consistent with those used during earlier industry studies (Davis *et al.,* 1985; Johnson *et al.,* 1986; Evans *et al.,* 1987; Miller *et al.,* 1997, 1998, 1999, 2002; Patterson, 2007). This will facilitate comparison and pooling of data where appropriate. However, the specific survey grids will be tailored to Shell's operations. During the 2010 drilling season Shell will coordinate and cooperate with the aerial surveys conducted by MMS/NMFS and any other groups conducting surveys in the same region.

For marine mammal monitoring flights, aircraft will be flown at approximately 120 knots (138 mph) ground speed and usually at an altitude of 1,000 ft (305 m). Surveys in the Beaufort Sea are directed at bowhead whales, and an altitude of 900–1,000 ft (274–305 m) is the lowest survey altitude that can normally be flown without concern about potential aircraft disturbance. Aerial surveys at an altitude of 1,000 ft (305 m) do not provide much information about seals but are suitable for both bowhead and beluga whales. The need for a 900–1000+ (374–305 m) ft cloud ceiling will limit the dates and times when surveys can be flown.

Two primary observers will be seated at bubble windows on either side of the aircraft and a third observer will observe part time and record data the rest of the time. All observers need bubble windows to facilitate downward viewing. For each marine mammal sighting, the observer will dictate the species, number, size/age/sex class when determinable, activity, heading, swimming speed category (if traveling), sighting cue, ice conditions (type and percentage), and inclinometer reading to the marine mammal into a digital recorder. The inclinometer reading will be taken when the animal's location is 90° to the side of the aircraft track, allowing calculation of lateral distance from the aircraft trackline.

Transect information, sighting data and environmental data will be entered into a GPS-linked computer by the third observer and simultaneously recorded on digital voice recorders for backup and validation. At the start of each transect, the observer recording data will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction (°T) and outside air temperature (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2 min intervals along the transect. The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects. Ice observations during aerial surveys will be recorded and satellite imagery may be used, where available, during post-season analysis to determine ice conditions adjacent to the survey area. These are standard practices for surveys of this type and are necessary in order to interpret factors responsible for variations in sighting rates.

During the late summer and fall, the bowhead whale is the primary species of concern, but belugas and gray whales are also present. To address concerns regarding deflection of bowheads at greater distances, the survey pattern around drilling operations has been designed to document whale distribution from about 25 mi (40 km) east of the drilling operations to about 37 mi (60 km) west of operations (*see* Figure 1 of Shell's 4MP).

Bowhead whale movements during the late summer/autumn are generally from east to west, and transects should be designed to intercept rather than parallel whale movements. The transect lines in the grid will be oriented north-south, equally spaced at 5 mi (8 km) and randomly shifted in the east-west direction for each survey by no more than the transect spacing. The survey grid will total about 808 mi (1,300 km) in length, requiring approximately 6 hours to survey at a speed of 120 knots (138 mph), plus ferry time. Exact lengths and durations will vary somewhat depending on the position of the drilling operation and thus of the grid, the sequence in which lines are flown (often affected by weather), and the number of refueling/rest stops.

Weather permitting, transects making up the grid in the Beaufort Sea will be flown in sequence from west to east. This decreases difficulties associated with double counting of whales that are (predominantly) migrating westward. The survey sequence around the drilling operation is designed to monitor the distribution of whales around the drilling operation.

(3) Acoustic Monitoring

As discussed earlier in this document, Shell will conduct SSV tests to establish the isopleths for the applicable safety radii. In addition, Shell proposes to use acoustic recorders to study bowhead deflections.

Shell plans to deploy arrays of acoustic recorders in the Beaufort Sea in 2010, similar to that which was done in 2007 and 2008 using Directional Autonomous Seafloor Acoustic Recorders (DASARs). These directional acoustic systems permit localization of bowhead whale and other marine mammal vocalizations. The purpose of the array will be to further understand, define, and document sound characteristics and propagation resulting from vessel-based drilling operations that may have the potential to cause deflections of bowhead whales from their migratory pathway. Of particular interest will be the east-west extent of deflection, if any (i.e., how far east of a sound source do bowheads begin to deflect and how far to the west beyond the sound source does deflection persist). Of additional interest will be the extent of offshore (or towards shore) deflection that might occur.

In previous work around seismic and drillship operations in the Alaskan Beaufort Sea, the primary method for studying this question has been aerial surveys. Acoustic localization methods will provide supplementary information for addressing the whale deflection question. Compared to aerial surveys, acoustic methods have the advantage of providing a vastly larger number of whale detections, and can operate day or night, independent of visibility, and to some degree independent of ice conditions and sea state—all of which prevent or impair aerial surveys. However, acoustic methods depend on the animals to call, and to some extent, assume that calling rate is unaffected by exposure to industrial noise. Bowheads call frequently in fall, but there is some evidence that their calling rate may be reduced upon exposure to industrial sounds, complicating interpretation. The combined use of acoustic and aerial survey methods will provide a suite of information that should be useful in assessing the potential effects of drilling operations on migrating bowhead whales.

Using passive acoustics with directional autonomous recorders, the locations of calling whales will be observed for a 6- to 10-week continuous monitoring period at five coastal sites (subject to favorable ice and weather conditions). Essential to achieving this objective is the continuous measurement of sound levels near the drillship.

Shell plans to conduct the whale migration monitoring using the passive acoustics techniques developed and used successfully since 2001 for monitoring the migration past Northstar production island northwest of Prudhoe Bay and from Kaktovik to Harrison Bay during the 2007 and 2008 migrations. Those techniques involve using DASARs to measure the arrival angles of bowhead calls at known locations, then triangulating to locate the calling whale.

In attempting to assess the responses of bowhead whales to the planned industrial operations, it will be essential to monitor whale locations at sites both near and far from industry activities. Shell plans to monitor at five sites along the Alaskan Beaufort coast as shown in Figure 10 of Shell's 4MP. The eastern-most site (#5 in Figure 10 of the 4MP) will be just east of Kaktovik (approximately 62 mi [100 km] west of the Sivulliq drilling area) and the western-most site (#1 in Figure 10 of the 4MP) will be in the vicinity of Harrison Bay (approximately 109 mi [175 km] west of Sivulliq) . Site 2 will be located west of Prudhoe Bay (approximately 68 mi [110 km] west of Sivulliq). Site 4 will be approximately 6.2 mi (10 km) east of the Sivulliq drilling area, and site 3 will be approximately 15.5 mi (25 km) west of Sivulliq. These five sites will provide information on possible migration deflection well in advance of whales encountering an industry operation and on "recovery" after passing such operations should a deflection occur.

The proposed geometry of DASARs at each site is comprised of seven DASARs oriented in a north-south pattern so that five equilateral triangles with 4.3-mi (7-km) element spacing is achieved. DASARs will be installed at planned locations using a GPS. However, each DASAR's orientation once it settles on the bottom is unknown and must be determined to know how to reference the call angles measured to the whales. Also, the internal clocks used to sample the acoustic data typically drift slightly, but linearly, by an amount up to a few seconds after 6 weeks of autonomous operation. Knowing the time differences within a second or two between DASARs is essential for identifying identical whale calls received on two or more DASARs.

Bowhead migration begins in late August with the whales moving westward from their feeding sites in the Canadian Beaufort Sea. It continues through September and well into October. However, because of the drilling schedule, Shell will attempt to install the 21 DASARs at three sites (3, 4 and 5) in early August. The remaining 14 DASARs will be installed at sites 1 and 2 in late August. Thus, Shell proposes to be monitoring for whale calls from before August 15 until sometime before October 15.

At the end of the season, the fourth DASAR in each array will be refurbished, recalibrated, and redeployed to collect data through the winter. The other DASARs in the arrays will be recovered. The redeployed DASARs will be programmed to record 35 min every 3 hours with a disk capacity of 10 months at that recording rate. This should be ample space to allow over-wintering from approximately mid-October 2010, through mid-July 2011.

Additional details on methodology and data analysis for the three types of monitoring described here (*i.e.,* vessel-based, aerial, and acoustic) can be found in the 4MP in Shell'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)).

NMFS has established an independent peer review panel to review Shell's 4MP for Exploration Drilling of Selected Lease Areas in the Alaskan Beaufort Sea in 2010. The panel met in late March 2010, and will provide comments to NMFS in mid-April 2010. After completion of the peer review, NMFS will consider all recommendations made by the panel, incorporate appropriate changes into the monitoring requirements of the IHA (if issued), and publish the panel's findings and recommendations in the final IHA notice of issuance or denial document.

Reporting Measures

(1) SSV Report

A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190-, 180-, 160-, and 120-dB (rms) radii of the drillship and the support vessels, will be submitted within 120 hr after collection and analysis of those measurements at the start of the field season. This report will specify the distances of the safety zones that were adopted for the exploratory drilling program.

(2) Technical Reports

The results of Shell's 2010 Camden Bay exploratory drilling monitoring program (i.e., vessel-based, aerial, and acoustic) will be presented in the "90-day" and Final Technical reports, as required by NMFS under IHAs. Shell proposes that the Technical Reports will include: (1) Summaries of monitoring effort (*e.g.,* total hours, total distances, and marine mammal distribution through study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals); (2) analyses of the effects of various factors influencing detectability of marine mammals (*e.g.,* sea state, number of observers, and fog/glare); (3) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover; (4) sighting rates of marine mammals during periods with and without drilling activities (and other variables that could affect detectability); (5) initial sighting distances versus drilling state; (6) closest point of approach versus drilling state; (7) observed behaviors and types of movements versus drilling state; (8) numbers of sightings/individuals seen versus drilling state; (9) distribution around the drillship and support vessels versus drilling state; and (10) estimates of take by harassment. This information will be reported for both the vessel-based and aerial monitoring.

Analysis of all acoustic data will be prioritized to address the primary questions, which are to: (a) Determine when, where, and what species of animals are acoustically detected on each DASAR; (b) analyze data as a whole to determine offshore bowhead distributions as a function of time; (c) quantify spatial and temporal variability in the ambient noise; and (d) measure received levels of drillship activities. The bowhead detection data will be used to develop spatial and temporal animal distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (*e.g.,* time of day, time of season, environmental conditions, ambient noise, vessel type, operation conditions).

The initial technical report is due to NMFS within 90 days of the completion of Shell's Beaufort Sea exploratory drilling program. The "90-day" 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.

(3) Comprehensive Report

In November, 2007, Shell (in coordination and cooperation with other Arctic seismic IHA holders) released a final, peer-reviewed edition of the 2006 Joint Monitoring Program in the Chukchi and Beaufort Seas, July–November 2006 (LGL, 2007). This report is available on the NMFS Protected Resources Web site (*see* **ADDRESSES**). In March, 2009, Shell released a final, peer-reviewed edition of the Joint Monitoring Program in the Chukchi and Beaufort Seas, Open Water Seasons, 2006–2007 (Ireland *et al.,* 2009). This report is also available on the NMFS Protected Resources Web site (*see* **ADDRESSES**). A draft comprehensive report for 2008 (Funk *et al.,* 2009) was provided to NMFS and those attending the Arctic Stakeholder Open-water Workshop in Anchorage, Alaska, on April 6–8, 2009. The 2008 report provides data and analyses from a number of industry monitoring and research studies carried out in the Chukchi and Beaufort Seas during the 2008 open-water season with comparison to data collected in 2006 and 2007. Reviewers plan to provide comments on the 2008 report to Shell. Once Shell is able to incorporate reviewer comments, the final 2008 report will be made available to the public. The 2009 draft comprehensive report is due to NMFS by mid-April 2010. NMFS will make this report available to the public upon receipt.

Following the 2010 drilling season a comprehensive report describing the vessel-based, aerial, and acoustic monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities, and other activities that occur in the Beaufort and/or Chukchi seas, and their impacts on marine mammals during 2010. The report will help to establish long-term data sets that can assist with the evaluation of changes in the Chukchi and Beaufort Sea ecosystems. The report will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior. The comprehensive report will be due to NMFS within 240 days of the date of issuance of the IHA (if issued).

(4) Notification of Injured or Dead Marine Mammals

Shell will notify NMFS' Office of Protected Resources and NMFS' Stranding Network within 48 hours of sighting an injured or dead marine mammal in the vicinity of drilling operations. Shell will provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

In the event that an injured or dead marine mammal is found by Shell that is not in the vicinity of the proposed drilling program, Shell will report the same information listed above to NMFS as soon as operationally feasible.

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 is anticipated as a result of the proposed drilling program. Anticipated impacts to marine mammals are associated with noise propagation from the drillship and associated support vessels. Additional disturbance to marine mammals may result from aircraft overflights and visual disturbance of the drillship or support vessels. However, based on the flight paths and altitude, impacts from aircraft operations are anticipated to be localized and minimal in nature.

The full suite of potential impacts to marine mammals from various industrial activities was described in detail in the "Potential Effects of the Specified Activity on Marine Mammals" section found earlier in this document. The potential effects of sound from the proposed exploratory drilling program might include one or more of the following: tolerance; masking of natural sounds; behavioral disturbance; non-auditory physical effects; and, at least in theory, temporary or permanent hearing impairment (Richardson *et al.,* 1995a). As discussed earlier in this document, the most common impact will likely be from behavioral disturbance, including avoidance of the ensonified area or changes in speed, direction, and/or diving profile of the animal. For reasons discussed previously in this document, hearing impairment (TTS and PTS) are highly unlikely to occur based on the fact that most of the equipment to be used during Shell's proposed drilling program does not have source levels high enough to elicit even mild TTS. Additionally, non-auditory physiological effects are anticipated to be minor, if any would occur at all. Finally, based on the proposed mitigation and monitoring measures described earlier in this document and the fact that the back-propagated source level for the drillship is estimated to be 175 dB re 1 μPa (rms), no injury or mortality of marine mammals is anticipated as a result of Shell's proposed exploratory drilling program.

For continuous sounds, such as those produced by drilling operations, NMFS uses a received level of 120-dB (rms) to indicate the onset of Level B harassment. Shell provided calculations for the 120-dB isopleths produced by the *Discoverer* and then used those isopleths to estimate takes by harassment. Shell also included modeling results of the 160-dB isopleths for the *Discoverer* and associated estimated takes by harassment. However, NMFS has used the 120-dB calculations to make the necessary MMPA preliminary findings. Shell provides a full description of the methodology used to estimate takes by harassment in its IHA application (see **ADDRESSES**), which is also provided in the following sections. However, this document only discusses the take estimates at the 120 dB level. Please refer to Shell's application for the full explanation and estimates at the 160 dB level.

Shell has requested authorization for bowhead, gray, and beluga whales and ringed, spotted, and bearded seals. Additionally, Shell provided exposure estimates and requested takes of ribbon seals, humpback whales, minke whales, harbor porpoise, and narwhal. However, as stated previously in this document, sightings of these species are rare, and the likelihood of occurrence of these species in the proposed drilling area is minimal.

Basis for Estimating "*Take by Harassment*"

"Take by Harassment" is described in this section and was calculated in Shell's application by multiplying the expected densities of marine mammals that may occur near the exploratory drilling operations by the area of water likely to be exposed to continuous sound levels of ≥120 dB. The single exception to this method is for the estimation of exposures of bowhead whales during the fall migration where more detailed data were available, allowing an alternate approach, described below, to be used. NMFS evaluated and critiqued the methods provided in Shell's application and determined that they were appropriate in order to make the necessary preliminary MMPA findings. This section describes the estimated densities of marine mammals that may occur in the project area. The area of water that may be ensonified to the above sound levels is described further in the "*Potential Number of Takes by Harassment*" subsection.

Marine mammal densities near the operation are likely to vary by season and habitat. However, sufficient published data allowing the estimation of separate densities during summer (July and August) and fall (September and October) are only available for beluga and bowhead whales. As noted above, exposures of bowhead whales during the fall are not calculated using densities (see below). Therefore, summer and fall densities have been estimated for beluga whales, and a summer density has been estimated for bowhead whales. Densities of all other species have been estimated to represent the duration of both seasons.

Marine mammal densities are also likely to vary by habitat type. In the Alaskan Beaufort Sea, where the continental shelf break is relatively close to shore, marine mammal habitat is often defined by water depth. Bowhead and beluga occurrence within nearshore (0–131 ft, 0–40 m), outer continental shelf (131–656 ft, 40–200 m), slope (656–6,562 ft, 200–2000 m), basin (>6,562 ft, 2000 m), or similarly defined habitats have been described previously (Moore *et al.,* 2000; Richardson and Thomson, 2002). The presence of most other species has generally only been described relative to the entire continental shelf zone (0–656 ft, 0–200 m) or beyond. Sounds produced by the drilling vessel are expected to drop below 120 dB within the nearshore zone (0–131 ft, 0–40 m, water depth) while sounds produced by ice-management activities, if they are necessary, are likely to also be present in the outer continental shelf (131–656 ft, 40–200 m). Sounds ≥120 dB are not expected to occur in waters >656 ft (200 m). Since the only instance in which sounds at the indicated levels may be introduced to the outer continental shelf would be during ice-management activities, and therefore ice-margin densities are more applicable, separate beluga and bowhead densities for the outer continental shelf have not been used in the calculations.

In addition to water depth, densities of marine mammals are likely to vary with the presence or absence of sea ice (see later for descriptions by species). At times during either summer or fall, pack-ice may be present in some of the area around the drilling operation. However, the retreat of sea ice in the Alaskan Beaufort Sea has been substantial in recent years, so Shell has assumed that only 33 percent of the area exposed to sounds ≥120 dB by the drilling vessel will be in ice margin habitat. Therefore, ice-margin densities of marine mammals in both seasons have been multiplied by 33 percent of the area exposed to sounds by the drilling vessel, while open-water (nearshore) densities have been multiplied by the remaining 67 percent of the area.

To provide some allowance for the uncertainties, "maximum estimates" as well as "average estimates" of the numbers of marine mammals potentially affected have been derived. For a few marine mammal species, several density estimates were available, and in those cases the mean and maximum estimates were determined from the survey data. In other cases, no applicable estimate (or perhaps a single estimate) was available, so correction factors were used to arrive at "average" and "maximum" estimates. These are described in detail in the following subsections. NMFS has determined that the average density data of marine mammal populations will be used to calculate estimated take numbers because these numbers are based on surveys and monitoring of marine mammals in the vicinity of the proposed project area. NMFS only used the "maximum" estimate for marine mammal species that are less likely to occur in the project area and for which little to no density information exists (*i.e.,* gray whales and spotted seals).

Detectability bias, quantified in part by $f(0)$, is associated with diminishing sightability with increasing lateral distance from the trackline. Availability bias [$g(0)$] refers to the fact that there is <100 percent probability of sighting an animal that is present along the survey trackline. Some sources of densities used below included these correction factors in their reported densities. In other cases the best available correction factors were applied to reported results when they had not been included in the reported data (*e.g.,* Moore *et al.,* 2000).

(1) Cetaceans

As noted above, the densities of beluga and bowhead whales present in the Beaufort Sea are expected to vary by season and location. During the early and mid-summer, most belugas and bowheads are found in the Canadian Beaufort Sea and Amundsen Gulf or adjacent areas. Low numbers are found in the eastern Alaskan Beaufort Sea. Belugas begin to move across the Alaskan Beaufort Sea in August, and bowheads do so toward the end of August.

Beluga Whales—Beluga density estimates were derived from data in

Moore *et al.* (2000). During the summer, beluga whales are most likely to be encountered in offshore waters of the eastern Alaskan Beaufort Sea or areas with pack ice. The summer beluga whale nearshore density (Table 6–1 in Shell's application and Table 1 here) was based on 7,447 mi (11,985 km) of on-transect effort and nine associated sightings that occurred in water ≤164 ft (50 m) in Moore *et al.* (2000; Table 6–2 in Shell's application and Table 2 here). A mean group size of 1.63, a *f*(0) value of 2.841, and a *g*(0) value of 0.58 from Harwood *et al.* (1996) were also used in the calculation. Moore *et al.* (2000) found that belugas were equally likely to occur in heavy ice conditions as open-water or very light ice conditions in summer in the Beaufort Sea, so the same density was used for both nearshore and ice-margin estimates (Table 6–1 in Shell's application and Table 1 here). The fall beluga whale nearshore density was based on 45,180.5 mi (72,711 km) of on-transect effort and 28 associated sightings that occurred in water ≤164 ft (50 m) reported in Moore *et al.* (2000). A mean group size of 2.9 (CV=1.9), calculated from all Beaufort Sea fall beluga sightings in ≤164 ft (50 m) of water present in the Bowhead Whale Aerial Survey Program database, along with the same *f*(0) and *g*(0) values from Harwood *et al.* (1996) were also used in the calculation. Moore *et al.* (2000) found that during the fall in the Beaufort Sea belugas occurred in moderate to heavy ice at higher rates than in light ice, so ice-margin densities were estimated to be twice the nearshore densities. Based on the CV of group size maximum estimates in both season and habitats were estimated as four times the average estimates. "Takes by harassment" of beluga whales during the fall in the Beaufort Sea were not calculated in the same manner as described for bowhead whales because of the relatively lower expected densities of beluga whales in nearshore habitat near the exploration drilling program and the lack of detailed data on the likely timing and rate of migration through the area.

TABLE 1—EXPECTED SUMMER (JUL–AUG) DENSITIES OF BELUGA AND BOWHEAD WHALES IN THE EASTERN ALASKAN BEAUFORT SEA. DENSITIES ARE CORRECTED FOR F(0) AND G(0) BIASES. SPECIES LISTED UNDER THE U.S. ESA AS ENDANGERED ARE SHOWN IN ITALIC

Species	Nearshore		Ice margin	
	Average density (# /km²)	Maximum density (# /km²)	Average density (# /km²)	Maximum density (# /km²)
Beluga	0.0030	0.0120	0.0030	0.0120
Bowhead whale	0.0186	0.0717	0.0186	0.0717

TABLE 2—EXPECTED FALL (SEP–NOV) DENSITIES OF BELUGA AND BOWHEAD WHALES IN THE EASTERN ALASKAN BEAUFORT SEA. DENSITIES ARE CORRECTED FOR F(0) AND G(0) BIASES. SPECIES LISTED UNDER THE U.S. ESA AS ENDANGERED ARE SHOWN IN ITALIC

Species	Nearshore		Ice margin	
	Average density (# /km²)	Maximum density (# /km²)	Average density (# /km²)	Maximum density (# /km²)
Beluga	0.0027	0.0108	0.0054	0.0216
Bowhead whale[a]	*NA*	*NA*	*NA*	*NA*

[a] See text for description of how bowhead whales estimates were made.

Bowhead Whales—Industry aerial surveys of the continental shelf near Camden Bay in 2008 recorded eastward migrating bowhead whales until July 12 (Lyons and Christie, 2009). No bowhead sightings were recorded again, despite continued flights until August 19. Aerial surveys by industry operators did not begin until late August of 2006 and 2007, but in both years bowheads were also recorded in the region before the end of August (Christie *et al.,* 2009). The late August sightings were likely of bowheads beginning their fall migration, so the densities calculated from those surveys were not used to estimate summer densities in this region. The three surveys in July 2008, resulted in density estimates of 0.0099, 0.0717, and 0.0186 whales/km², respectively. The estimate of 0.0186 whales/km² was used as the average summer nearshore density, and the estimate of 0.0717 whales/km² was used as the maximum. Sea ice was not present during these surveys. Moore *et al.* (2000) reported that bowhead whales in the Alaskan Beaufort Sea were distributed uniformly relative to sea ice, so the same nearshore densities were used for ice-margin habitat.

During the fall, most bowhead whales will be migrating west past the exploration drilling program, so it is less accurate to assume that the number of individuals present in the area from one day to the next will be static. However, feeding, resting, and milling behaviors are not entirely uncommon at this time and location either. In order to incorporate the movement of whales past the planned operations, and because the necessary data are available, Shell developed an alternate method of calculating the number of individual bowheads exposed to sounds produced by the exploration drilling program from the method used to calculate the number of exposures for bowheads in summer and the other marine mammal species for the entire season. The method is founded on estimates of the proportion of the population that would pass within the ≥120 dB zone on a given day in the fall during the exploration drilling program. Based on the fact that most bowhead whales will be engaged in the fall migration at this time, NMFS preliminarily determined that this method was appropriate for estimating the number of individual bowhead whales that may be exposed to drilling sounds after August 25.

Exploration drilling will be suspended on August 25 prior to the start of the bowhead subsistence hunts at Kaktovik and Nuiqsut (Cross Island) and will be resumed when the hunts are concluded. After the completion of the subsistence hunts (expected in mid-September), approximately 40 days of activity will be required to complete the planned drilling operations. The current population size would be approximately 14,247 individuals based on a 2001 population of 10,545 (Zeh and Punt, 2005) and a continued annual growth rate of 3.4 percent (Allen and Angliss, 2010). Based on data in Richardson and Thomson (2002, Appendix 9.1), the number of whales expected to pass each day after conclusion of the bowhead subsistence hunts (assumed to be September 15) was estimated as a proportion of the population. Minimum and maximum estimates of the number of whales passing each day were not available, so a single estimate based on the 10-day moving average presented by Richardson and Thomson (2002) was used. Richardson and Thomson (2002) also calculated the proportion of animals within water depth bins (<66 ft [20m], 66–131 ft [20–40m], 131–656 ft [40–200m], and >656 ft [200m]). Using this information, Shell multiplied the total number of whales expected to pass the drilling program each day by the proportion of whales that would be in each depth category to estimate how many individuals would be within each depth bin on a given day. The proportion of each depth bin falling within the ≥120 dB zone was then multiplied by the number of whales within the respective bins to estimate the total number of individuals that would be exposed on each day. This was repeated for a total of 40 days (September 15 to October 24), and the results were summed to estimate the total number of bowhead whales that might be exposed to ≥120 dB during the migration period in the Beaufort Sea. If the hunts at Kaktovik and Cross Island (Nuiqsut) end later than September 15, the number of exposures calculated by Shell would be an overestimate, as Shell will still need to end active operations by the end of October because of the increased chance of their being additional ice covering the drill sites later in the season.

Gray Whales—For gray whales, densities are likely to vary somewhat by season, but differences are not expected to be great enough to require estimation of separate densities for the two seasons. Gray whales are not expected to be present in large numbers in the Beaufort Sea during the fall but small numbers may be encountered during the summer. They are most likely to be present in nearshore waters. Since this species occurs infrequently in the Beaufort Sea, little to no data are available for the calculation of densities. Minimal densities have therefore been assigned for calculation purpose and to allow for chance encounters (see Table 6–3 in Shell's application and Table 3 here).

TABLE 3—EXPECTED DENSITIES OF CETACEANS (EXCLUDING BELUGA AND BOWHEAD WHALE) AND SEALS IN THE ALASKAN BEAUFORT SEA

Species	Nearshore		Ice margin	
	Average density (# /km^2)	Maximum density (# /km^2)	Average density (# /km^2)	Maximum density (# /km^2)
Odontocetes:				
Monodontidae:				
Narwhal	0.0000	0.0000	0.0000	0.0001
Phocoenidae:				
Harbor porpoise	0.0001	0.0004	0.0000	0.0000
Mysticetes:				
Gray whale	0.0001	0.0004	0.0000	0.0000
Pinnipeds:				
Bearded seal	0.0181	0.0724	0.0128	0.0512
Ribbon seal	0.0001	0.0004	0.0001	0.0004
Ringed seal	0.3547	1.4188	0.2510	1.0040
Spotted seal	0.0037	0.0149	0.0001	0.0004

(2) Pinnipeds

Extensive surveys of ringed and bearded seals have been conducted in the Beaufort Sea, but most surveys have been conducted over the landfast ice, and few seal surveys have occurred in open-water or in the pack ice. Kingsley (1986) conducted ringed seal surveys of the offshore pack ice in the central and eastern Beaufort Sea during late spring (late June). These surveys provide the most relevant information on densities of ringed seals in the ice margin zone of the Beaufort Sea. The density estimate in Kingsley (1986) was used as the average density of ringed seals that may be encountered in the ice margin (Table 6–3 in Shell's application and Table 3 here). The average ringed seal density in the nearshore zone of the Alaskan Beaufort Sea was estimated from results of ship–based surveys at times without seismic operations reported by Moulton and Lawson (2002; Table 6–3 in Shell's application and Table 3 here).

Densities of bearded seals were estimated by multiplying the ringed seal densities by 0.051 based on the proportion of bearded seals to ringed seals reported in Stirling *et al.* (1982; Table 6–3 in Shell's application and Table 3 here). Spotted seal densities in the nearshore zone were estimated by summing the ringed seal and bearded seal densities and multiplying the result by 0.015 based on the proportion of spotted seals to ringed plus bearded seals reported in Moulton and Lawson (2002; Table 6–3 in Shell's application and Table 3 here). Minimal values were assigned as densities in the ice–margin zones (Table 6–3 in Shell's application and Table 3 here).

Potential Number of Takes by Harassment

(1) Estimates of the Number of Individuals That May Be Exposed to Sounds ≥120 dB

Just because a marine mammal is exposed to drilling sounds ≥120 dB (rms), this does not mean that it will *actually* exhibit a disruption of behavioral patterns in response to the sound source. Rather, the estimates provided here are simply the best estimates of the number of animals that potentially could have a behavioral modification due to the noise. However, not all animals react to sounds at this low level, and many will not show strong reactions (and in some cases any reaction) until sounds are much stronger. There are several variables that determine whether or not an individual animal will exhibit a response to the sound, such as the age of the animal, previous exposure to this type of anthropogenic sound, habituation, *etc.*

Numbers of marine mammals that might be present and potentially disturbed (*i.e.,* Level B harassment) are estimated below based on available data about mammal distribution and densities at different locations and times of the year as described previously. Exposure estimates are based on a single drillship (*Discoverer*) operating in Camden Bay beginning in July. Shell will not operate the *Discoverer* and associated vessels in Camden Bay during the 2010 Kaktovik and Nuiqsut (Cross Island) fall bowhead whale subsistence harvests. Shell will suspend exploration activities on August 25, prior to the beginning of the hunts, will resume activities in Camden Bay after conclusion of the subsistence harvests, and complete exploration activities on or about October 31, 2010. Actual drilling may occur on approximately 74 days while the *Discoverer* is in Camden Bay, approximately half of which would occur before and after the fall bowhead subsistence hunts.

The number of different individuals of each species potentially exposed to received levels ≥120 dB re 1 μPa within each season and habitat zone was estimated by multiplying:

- The anticipated area to be ensonified to the specified level in the time period and habitat zone to which a density applies, by
- The expected species density.

The numbers of exposures were then summed for each species across the seasons and habitat zones.

(2) Estimated Area Exposed to Sounds ≥120 dB

The total area of a 4.6 mi (7.4 km) radius circle (66.4 mi² [172 km²]; representing 1.5 × the ≥120 dB radius of 3.06 mi [4.93 km] modeled by JASCO for the *Discoverer*) was used to calculate the area ensonified to ≥120 dB around the *Discoverer* operating at either of the planned drill sites (Sivulliq N and Torpedo H). This area falls within water less than 131 ft (40 m) deep at both planned locations. The area exposed to sounds by drilling occurs in waters ≤131 ft (40 m) deep, so 67 percent was multiplied by the nearshore zone densities and the remaining 33 percent by the ice-margin densities.

For analysis of potential effects on migrating bowhead whales, Shell calculated the total distance perpendicular to the migration path ensonified to ≥120 dB (4.6 mi [7.4 km] radius × 2 = 9.2 mi [14.8 km]) by the *Discoverer.* This represents 41 percent of the 22 mi (36 km) between the barrier islands and the 131 ft (40 m) bathymetry line, so it was assumed that 41 percent of the bowheads migrating within the nearshore zone (water depth 0–131 ft [0–40 m]) may be exposed to sounds ≥120 dB, if they showed no avoidance of the drilling operations.

Cetaceans—Cetacean species potentially exposed to drilling program sounds with received levels ≥120 dB would involve bowhead, gray, and beluga whales. Shell also included some maximum exposure estimates for narwhal, harbor porpoise, humpback whale, and minke whale. However, as stated previously in this document, NMFS has determined that authorizing take of these four cetacean species is not warranted because the probability of these species being present in the drilling area is remote. Average and maximum estimates of the number of individual cetaceans exposed, in descending order, are bowhead whale (1,968 and 1,977), beluga whale (1 and 4), and gray whale (0 and 5). Table 6–7 in Shell's application and Table 4 here summarize the number of marine mammal species or stocks that may experience Level B harassment.

The estimates show that one endangered cetacean species (the bowhead whale) is expected to be exposed to sounds ≥120 dB unless bowheads avoid the area around the drill sites (Tables 6–4 and 6–5 in Shell's application). Migrating bowheads are likely to do so to some extent, though many of the bowheads engaged in other activities, particularly feeding and socializing, probably will not (Richardson, 2004).

Pinnipeds—The ringed seal is the most widespread and abundant pinniped in ice-covered arctic waters, and there appears to be a great deal of year-to-year variation in abundance and distribution of these marine mammals. Ringed seals account for a large number of marine mammals expected to be encountered during the exploration drilling program, and hence exposed to sounds with received levels ≥120 dB. The average (and maximum) estimate is that 109 (436) ringed seals might be exposed to sounds with received levels ≥120 dB from the exploration drilling program.

Two additional seal species are expected to be encountered. Average and maximum estimates for bearded seal exposures to sound levels ≥120 dB were 6 and 22, respectively. For spotted seal these exposure estimates were 1 and 3, respectively. Table 6–7 in Shell's application and Table 4 here summarize the number of marine mammal species or stocks that may experience Level B harassment.

TABLE 4—SUMMARY OF THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥120 DB AND (≥160 DB) DURING SHELL'S PLANNED EXPLORATION DRILLING PROGRAM NEAR CAMDEN BAY IN THE BEAUFORT SEA, ALASKA, JULY–OCTOBER 31, 2010

Species	Total number of exposure to sound levels >120 dB and (≥160 dB)	
	Avg.	Max.
Odontocetes:		
Monodontidae:		
Beluga	1 (0)	4 (0)
Narwhal	0 (0)	5 (5)
Phocoenidae:		
Harbor porpoise	0 (0)	5 (5)
Mysticetes:		
Bowhead whale [a]	1968 (14)	1977 (14)
Gray whale	0 (0)	5 (5)
Humpback whale	0 (0)	5 (5)

TABLE 4—SUMMARY OF THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥120 DB AND (≥160 DB) DURING SHELL'S PLANNED EXPLORATION DRILLING PROGRAM NEAR CAMDEN BAY IN THE BEAUFORT SEA, ALASKA, JULY–OCTOBER 31, 2010—Continued

Species	Total number of exposure to sound levels >120 dB and (≥160 dB)	
	Avg.	Max.
Minke whale	0 (0)	5 (5)
Total Cetaceans	1968 (14)	1992 (29)
Pinnipeds:		
Bearded seal	6 (0)	22 (0)
Ringed seal	109 (0)	436 (0)
Ribbon seal	0 (0)	5 (5)
Spotted seal	1 (0)	5 (5)
Total Pinnipeds	115 (0)	467 (10)

Estimated Take Conclusions

As stated previously, NMFS' practice has been to apply the 120 dB re 1 μPa (rms) received level threshold for underwater continuous sound levels to determine whether take by Level B harassment occurs. However, not all animals react to sounds at this low level, and many will not show strong reactions (and in some cases any reaction) until sounds are much stronger. Southall *et al.* (2007) provide a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall *et al.* (2007)). Tables 15, 17, and 21 in Southall *et al.* (2007) outline the numbers of low-frequency and mid-frequency cetaceans and pinnipeds in water, respectively, reported as having behavioral responses to non-pulses in 10–dB received level increments. These tables illustrate, especially for low- and mid-frequency cetaceans, that more intense observed behavioral responses did not occur until sounds were higher than 120 dB (rms). Many of the animals had no observable response at all when exposed to anthropogenic sound at levels of 120 dB (rms) or even higher.

Although the 120–dB isopleth for the drillship may seem fairly expansive (*i.e.,* 4.6 mi [7.4 km], which includes the 50 percent inflation factor), the zone of ensonification begins to shrink dramatically with each 10–dB increase in received sound level. Table 5 here depicts the radii for the 120, 130, 140, 150, and 160 dB received levels for the drillship. As stated previously, source levels are expected to be 175 dB (rms). For an animal to receive a sound at this level, it would have to be within several meters of the vessel, which is unlikely, especially give the fact that certain species are likely to avoid the area (as described earlier in this document).

TABLE 5—MODELED SOUND LEVELS AT THE 120, 130, 140, 150, AND 160 DB ISOPLETHS FOR THE DRILLSHIP—THESE DISTANCES DO NOT INCLUDE THE 50 PERCENT INFLATION FACTOR USED FOR ESTIMATING TAKE

Received levels (dB re 1 μPa rms)	Drillship (distance in m)
160	35
150	55
140	216
130	1,358
120	4,930

Table 6–7 in Shell's application and Table 4 here present the number of each species that may be exposed to sounds ≥160 dB. This number is substantially less than the number of individuals from each species that may be exposed to sounds at the 120 dB level. For example, 1,968 bowhead whales are estimated to be exposed to sounds ≥120 dB; however, only 14 bowhead whales are estimated to be exposed to sounds ≥160 dB. Additionally, using the same calculations, only 541, 86, and 22 bowhead whales are estimated to be exposed to sounds ≥130, 140, and 150 dB, respectively. Therefore, while 1,968 bowhead whales may occur within 4.6 mi (7.4 km) of the drillship, which is an area 1.5 × greater than the 120 dB radius, only a small percentage of the animals would occur in areas with received sound levels that may elicit more intense observed behavioral responses.

The ringed seal is the species with the second highest predicted encounter rate during Shell's proposed drilling program. Although there is the potential for 109 ringed seals to be exposed to sounds ≥120 dB, this number drops to zero at the 160 dB level. Additionally, using the same calculations, only 8 ringed seals are estimated to be exposed to sounds ≥130, and none are expected to be exposed to sounds at the 140–, 150—, or 160—dB levels. Moreover, fewer studies have been conducted on the reactions of pinnipeds to continuous sound sources. However, it appears that most pinnipeds are more tolerant and less responsive to sounds at lower received levels than most cetaceans, especially mysticetes.

NMFS is proposing to authorize the average take estimates provided in Table 6–7 of Shell's application and Table 4 here. The only exceptions to this are for the gray whale since the average estimate is zero and for the beluga whale to account for group size. Therefore, NMFS proposes to authorize the take of 4 beluga whales, 1,968 bowhead whales, 5 gray whales, 6 bearded seals, 109 ringed seals, and 1 spotted seal. For beluga and gray whales, this represents 0.01 percent of the Beaufort Sea population of approximately 39,258 beluga whales (Angliss and Allen, 2009) and 0.03 percent of the Eastern North Pacific stock of approximately 17,752 gray whales. This also represents 13.8 percent of the Bering-Chukchi-Beaufort population of 14,247 individuals assuming 3.4 percent annual population growth from the 2001 estimate of 10,545 animals (Zeh and Punt, 2005). The take estimates presented for bearded, ringed, and spotted seals represent 0.1, 0.04, and 0.1 percent of the Bering-Chukchi-Beaufort populations for each species, respectively.

With the exception of the subsistence mitigation measure of shutting down during the Nuiqsut and Kaktovik fall bowhead whale hunts, these take estimates do not take into account any of the mitigation measures described previously in this document. Additionally, if the fall bowhead hunts end after September 15, and Shell still concludes activities on October 31, then fewer animals will be exposed to drilling sounds, especially bowhead whales, as more of them will have migrated past the area in which they would be exposed to sound levels of 120 dB or greater prior to Shell resuming active operations.

Lastly, even though Shell has indicated that the Camden Bay drilling program will occur for 74 days between July 10 and October 31, 2010, Shell has requested that the IHA (if issued) be valid for a full year. NMFS is proposing to grant this request in the event that Shell is unable to conduct active operations for the full 74 days. Therefore, depending on the expiration date of the IHA (if issued), Shell could potentially work early in the 2011 open-water season. The take numbers presented here (and in Shell's application) are based on 74 days of active operations. Therefore, these numbers account for this situation. In fact, these numbers may then be an overestimate, as fewer animals, especially bowhead and beluga whales, would be expected at the drill sites in early July 2011.

Negligible Impact and Small Numbers Analysis and Preliminary Determination

NMFS has defined "negligible impact" in 50 CFR 216.103 as "* * * an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." In making a negligible impact determination, NMFS considers a variety of factors, including but not limited to: (1) The number of anticipated mortalities; (2) the number and nature of anticipated injuries; (3) the number, nature, intensity, and duration of Level B harassment; and (4) the context in which the takes occur.

No injuries or mortalities are anticipated to occur as a result of Shell's proposed Camden Bay exploratory drilling program, 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. Takes will be limited to Level B behavioral harassment. Although it is possible that some individuals may be exposed to sounds from drilling operations more than once, during the migratory periods it is less likely that this will occur since animals will continue to move westward across the Beaufort Sea. This is especially true for bowhead whales that will be migrating past the drilling operations beginning in mid- to late September (depending on the date Shell resumes activities after the shutdown period for the fall bowhead subsistence hunts by the villages of Kaktovik and Nuiqsut).

Some studies have shown that bowhead whales will continue to feed in areas of seismic operations (*e.g.,* Richardson, 2004). Therefore, it is possible that some bowheads may continue to feed in an area of active drilling operations. It is important to note that the sounds produced by drilling operations are of a much lower intensity than those produced by seismic airguns. Should bowheads chose to feed in the ensonified area instead of avoiding the sound, individuals may be exposed to sounds at or above 120 dB (rms) for several hours to days, depending on how long the individual animal chooses to remain in the area to feed. As noted previously, many animals perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hr cycle). As discussed here, some bowhead whales may decide to remain in Camden Bay for several days to feed; however, they are not expected to be feeding for 24 hours straight each day. While feeding in an area of increased anthropogenic sound may potentially result in increased stress, it is not anticipated that the level of sound produced by the exploratory drilling operations and the amount of time that an individual whale may remain in the area to feed would result in extreme physiological stress to the animal. Additionally, if an animal is excluded from Camden Bay for feeding because it decides to avoid the ensonified area, this may result in some extra energy expenditure for the animal to find an alternate feeding ground. However, Camden Bay is one of a few feeding areas for bowhead whales in the U.S. Arctic Ocean. The disruption to feeding is not anticipated to have more than a negligible impact on the affected species or stock.

Some bowhead whales have been observed feeding in the Camden Bay area in recent years. There has also been recent evidence that some bowhead whales continued feeding in close proximity to seismic sources (*e.g.,* Richardson, 2004). The sounds produced by the drillship are of lower intensity than those produced by seismic airguns. Therefore, if animals remain in ensonified areas to feed, they would be in areas where the sound levels are not high enough to cause injury (based on the fact that source levels are not expected to reach levels known to cause even slight, mild TTS, a non-injurious threshold shift).

Beluga whales are more likely to occur in the project area after the recommencement of activities in September than in July or August. Should any belugas occur in the area of active drilling, it is not expected that they would remain in the area for a prolonged period of time, as their westward migration usually occurs further offshore (more than 37 mi [60 km]) and in deeper waters (more than 656 ft [200 m]) than that planned for the location of Shell's Camden Bay well sites. Gray whales do not frequently occur in the Camden Bay area of the Beaufort Sea, so exposures to industrial sound are not expected to last for prolonged periods (*i.e.,* several days or weeks). The exposure of cetaceans to sounds produced by exploratory drilling operations is not expected to result in more than Level B harassment and is anticipated to have no more than a negligible impact on the affected species or stock.

Some individual pinnipeds may be exposed to drilling sounds more than once during the time frame of the project. This may be especially true for ringed seals, which occur in the Beaufort Sea year-round and are the most frequently encountered pinniped species in the area. However, as stated previously in this document, pinnipeds appear to be more tolerant of anthropogenic sound, especially at lower received levels, than other marine mammals, such as mysticetes. NMFS has preliminarily determined that the exposure of pinnipeds to sounds produced by exploratory drilling operations is not expected to result in more than Level B harassment and is anticipated to have no more than a negligible impact on the animals.

Of the six marine mammal species likely to occur in the proposed drilling area, only the bowhead whale is listed as endangered under the ESA. The species is also designated as "depleted" under the MMPA. Despite these designations, the Bering-Chukchi-Beaufort stock of bowheads has been increasing at a rate of 3.4 percent annually for nearly a decade (Allen and Angliss, 2010). Additionally, during the 2001 census, 121 calves were counted, which was the highest yet recorded. The calf count provides corroborating evidence for a healthy and increasing population (Allen and Angliss, 2010). There is no critical habitat designated in the U.S. Arctic for the bowhead whale. The bearded and ringed seals are "candidate species" under the ESA, meaning they are currently being considered for listing but are not designated as depleted under the MMPA. None of the other three species that may occur in the project area are listed as threatened or endangered under the ESA or designated as depleted under the MMPA.

Potential impacts to marine mammal habitat were discussed previously in this document (see the "Anticipated Effects on Habitat" section). Although some disturbance is possible to food sources of marine mammals, the impacts are anticipated to be minor enough as to not affect rates of recruitment or survival of marine mammals in the area. Based on the vast size of the Arctic Ocean where feeding by marine mammals occurs versus the localized area of the drilling program, any missed feeding opportunities in the direct project area would be minor based on the fact that other feeding grounds exist elsewhere.

The estimated takes proposed to be authorized represent 0.01 percent of the Beaufort Sea population of approximately 39,258 beluga whales (Angliss and Allen, 2009), 0.03 percent of the Eastern North Pacific stock of approximately 17,752 gray whales, and 13.8 percent of the Bering-Chukchi-Beaufort population of 14,247 individuals assuming 3.4 percent annual population growth from the 2001 estimate of 10,545 animals (Zeh and Punt, 2005). The take estimates presented for bearded, ringed, and spotted seals represent 0.1, 0.04, and 0.1 percent of the Bering-Chukchi-Beaufort populations for each species, respectively. These 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. Additionally, these numbers are likely an overestimate, as these take numbers were calculated using a 50 percent inflation factor of the 120-dB radius, which is a conservative approach recommended by some acousticians when modeling a new sound source in a new location. This is fairly conservative given the fact that the radii were based on results from a similar drillship (*i.e.,* the *Northern Explorer II*). SSV tests may reveal that the Level B harassment zone may in fact be smaller than that used to estimate take. If the SSV tests reveal that the Level B harassment zone is slightly larger than that of the *Northern Explorer II,* the 50 percent inflation factor should cover the discrepancy. Moreover, 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.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that Shell's proposed Camden Bay exploratory drilling program may result in the incidental take of small numbers of marine mammals, by Level B harassment only, and that the total taking from the exploratory drilling program will have a negligible impact on 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 drilling activities 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.

The subsistence communities in the Beaufort Sea that have the potential to be impacted by Shell's Camden Bay drilling program include Kaktovik, Nuiqsut, and Barrow. Kaktovik is a coastal community 60 mi (96.6 km) east of the project area. Nuiqsut is 118 mi (190 km) west of the project area and about 20 mi (32 km) inland from the coast along the Colville River. Cross Island, from which Nuiqsut hunters base their bowhead whaling activities, is 47 mi (75.6 km) southwest of the project area. Barrow, the community farthest from the project area, lies 298 mi (479.6 km) west of Shell's Camden Bay drill sites.

(1) Bowhead Whales

Of the three communities, Barrow is the only one that currently participates in a spring bowhead whale hunt. However, this hunt is not anticipated to be affected by Shell's activities, as the spring hunt occurs in late April to early May, and Shell's Camden Bay drilling program will not begin until July 10, at the earliest.

All three communities participate in a fall bowhead hunt. In autumn, westward-migrating bowhead whales typically reach the Kaktovik and Cross Island (Nuiqsut hunters) areas by early September, at which points the hunts begin (Kaleak, 1996; Long, 1996; Galginaitis and Koski, 2002; Galginaitis and Funk, 2004, 2005; Koski *et al.,* 2005). Around late August, the hunters from Nuiqsut establish camps on Cross Island from where they undertake the fall bowhead whale hunt. The hunting period starts normally in early September and may last as late as mid-October, depending mainly on ice and weather conditions and the success of the hunt. Most of the hunt occurs offshore in waters east, north, and northwest of Cross Island where bowheads migrate and not inside the barrier islands (Galginaitis, 2007). Hunters prefer to take bowheads close to shore to avoid a long tow, but Braund and Moorehead (1995) report that crews may (rarely) pursue whales as far as 50 mi (80 km) offshore. Whaling crews use Kaktovik as their home base, leaving the village and returning on a daily basis. The core whaling area is within 12 mi (19.3 km) of the village with a periphery ranging about 8 mi (13 km) farther, if necessary. The extreme limits of the Kaktovik whaling limit would be the middle of Camden Bay to the west. The timing of the Kaktovik bowhead whale hunt roughly parallels the Cross Island whale hunt (Impact Assessment Inc, 1990b; SRB&A, 2009: Map 64). In recent years, the hunts at Kaktovik and Cross Island have usually ended by mid- to late September.

Westbound bowheads typically reach the Barrow area in mid-September, and are in that area until late October (Brower, 1996). However, over the years, local residents report having seen a small number of bowhead whales feeding off Barrow or in the pack ice off Barrow during the summer. Recently, autumn bowhead whaling near Barrow has normally begun in mid-September to early October, but in earlier years it began as early as August if whales were observed and ice conditions were favorable (USDI/BLM, 2005). The recent decision to delay harvesting whales until mid-to-late September has been made to prevent spoilage, which might occur if whales were harvested earlier in the season when the temperatures tend to be warmer. Whaling near Barrow can continue into October, depending on the quota and conditions.

Shell anticipates arriving on location in Camden Bay around July 10 and continuing operations until August 25. Shell has stated that it will suspend all operations on August 25 for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The *Discoverer* and support vessels will leave the Camden Bay project area, will move to a location at or north of 71.25°N. latitude and at or west of 146.4°W. longitude, and will return to resume activities after the Nuiqsut (Cross Island) and Kaktovik bowhead hunts conclude. Depending on when Nuiqsut and Kaktovik declare their hunts closed, drilling operations may resume in the middle of the Barrow fall bowhead hunt.

(2) Beluga Whales

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 one percent 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.

There has been minimal harvest of beluga whales in Beaufort Sea villages in recent years. Additionally, if belugas are harvested, it is usually in conjunction with the fall bowhead harvest. Shell will not be operating during the Kaktovik and Nuiqsut fall bowhead harvests.

(3) Ice Seals

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. An annual bearded seal harvest occurs in the vicinity of Thetis Island (which is a considerable distance from Shell's proposed Camden Bay drill sites) 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, which is more than 100 mi (161 km) from Shell's proposed drill sites.

Although there is the potential for some of the Beaufort villages to hunt ice seals during the summer and fall months while Shell is conducting exploratory drilling operations, the primary sealing months occur outside of Shell's operating time frame. Additionally, some of the more established seal hunts that do occur in the Beaufort Sea, such as the Colville delta area hunts, are located a significant distance (in some instances 100 mi [161 km] or more) from the proposed 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 Shell's proposed drilling program have the potential to impact marine mammals hunted by Native Alaskans. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously in this document) 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 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.

In the case of subsistence hunts for bowhead whales in the Beaufort Sea, there could be an adverse impact on the hunt if the whales were deflected seaward (further from shore) in traditional hunting areas. The impact would be that whaling crews would have to travel greater distances to intercept westward migrating whales, thereby creating a safety hazard for whaling crews and/or limiting chances of successfully striking and landing bowheads.

Plan of Cooperation (POC)

Regulations at 50 CFR 216.104(a)(12) require IHA applicants for activities that take place in Arctic waters to provide a POC 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. Shell has developed a Draft POC for its 2010 Camden Bay, Beaufort Sea, Alaska, exploration drilling program to minimize any adverse impacts on the availability of marine mammals for subsistence uses. A copy of the Draft POC was distributed to the communities, subsistence user groups, NMFS, and other Federal and State agencies in May 2009. An updated Communications Plan was then submitted to NMFS as an attachment to the POC in July 2009. Shell conducted POC meetings throughout 2009 regarding its planned 2010 activities in both the Beaufort and Chukchi Seas. During these meetings, Shell focused on lessons learned from prior years' activities and presented mitigation measures for avoiding potential conflicts, which are outlined in the 2010 POC and this document. For this Camden Bay drilling program, Shell's POC with Chukchi Sea villages primarily addresses the issue of transit of vessels, whereas the POC with Beaufort Sea villages addresses vessel transit, drilling, and associated activities. Communities that were consulted regarding Shell's 2010 Arctic

Ocean operations include: Barrow, Kaktovik, Wainwright, Kotzebue, Kivalina, Point Lay, and Point Hope. Attempts were made to meet individually with whaling captains and to hold a community meeting in Nuiqsut; however, after receipt of a request by the Mayor, the scheduled meeting was cancelled. Shell subsequently sent correspondence to all post office box holders in Nuiqsut on February 26, 2009, indicating its willingness to visit and have dialogue on the proposed plans.

Beginning in early January 2009, Shell held one-on-one meetings with representatives from the North Slope Borough (NSB) and Northwest Arctic Borough (NWAB), subsistence-user group leadership, and Village Whaling Captain Association representatives. Shell's primary purpose in holding individual meetings was to inform and prepare key leaders, prior to the public meetings, so that they would be prepared to give appropriate feedback on planned activities.

Shell presented the proposed project to the NWAB Assembly on January 27, 2009, to the NSB Assembly on February 2, 2009, and to the NSB and NWAB Planning Commissions in a joint meeting on March 25, 2009. Meetings were also scheduled with representatives from the Alaska Eskimo Whaling Commission (AEWC), and presentations on proposed activities were given to the Inupiat Community of the Arctic Slope, and the Native Village of Barrow. A full list of POC meetings conducted by Shell between January and April 2009 can be found in Table 4.2–1 of Shell's POC. Shell has successfully completed additional POC meetings with several communities since submitting the Draft POC, including:

- June 1, 2009: NSB Assembly meeting;
- June 2, 2009: Point Lay meeting with village leadership;
- June 3, 2009: Kaktovik meeting with village leadership;
- June 17, 2009: Point Hope meeting with village leadership;
- August 5, 2009: NWAB Assembly meeting; and
- August 27, 2009: NSB Planning Commission meeting.

On December 8, 2009, Shell held consultation meetings with representatives from the various marine mammal commissions. Prior to drilling in 2010, Shell will also hold additional consultation meetings with the affected communities and subsistence user groups, NSB, and NWAB to discuss the mitigation measures included in the POC.

The following mitigation measures, plans and programs, are integral to the POC and were developed during consultation with potentially affected subsistence groups and communities. These measures, plans, and programs will be implemented by Shell during its 2010 exploration drilling operations in both the Beaufort and Chukchi Seas to monitor and mitigate potential impacts to subsistence users and resources. The mitigation measures Shell has adopted and will implement during its 2010 Camden Bay exploration drilling operations are listed and discussed below. This most recent version of Shell's planned mitigation measures was presented to community leaders and subsistence user groups starting in January of 2009 and has evolved since in response to information learned during the consultation process.

To minimize any cultural or resource impacts to subsistence whaling activities from its exploration operations, Shell will suspend drilling activities on August 25, 2010, prior to the start of the Kaktovik and Cross Island bowhead whale hunting season. The drillship and associated vessels will remain outside of the Camden Bay area during the hunt. Shell will resume drilling operations after the conclusion of the hunt and, depending on ice and weather conditions, continue its exploration activities through October 31, 2010. In addition to the adoption of this project timing restriction, Shell will implement the following additional measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunts for marine mammals:

(1) The drillship and support vessels will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. In the event the transit outside of the polynya zone results in Shell having to break ice (as opposed to managing ice by pushing it out of the way), the drillship and support vessels will enter into the polynya zone far enough so that ice breaking is not necessary. If it is necessary to move into the polynya zone, Shell will notify the local communities of the change in the transit route through the Communication Centers (Com Centers);

(2) Shell has developed a Communication Plan and will implement the plan before initiating exploration drilling operations to coordinate activities with local subsistence users as well as Village Whaling Associations in order to minimize the risk of interfering with subsistence hunting activities and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Com and Call Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell's proposed activities in 2010;

(3) Shell will employ local Subsistence Advisors from the Beaufort and Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunt. There will be a total of nine subsistence advisor-liaison positions (one per village), to work approximately 8-hours per day and 40-hour weeks through Shell's 2010 exploration project. The subsistence advisor will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and advise as to ways to minimize and mitigate potential impacts to subsistence resources during the drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. A subsistence advisor handbook will be developed prior to the operational season to specify position work tasks in more detail;

(4) Shell will recycle drilling muds (*e.g.,* use those muds on multiple wells), to the extent practicable based on operational considerations (*e.g.,* whether mud properties have deteriorated to the point where they cannot be used further), to reduce discharges from its operations. At the end of the season excess water base fluid will be pre-diluted to a 30:1 ratio with seawater and then discharged;

(5) Shell will implement flight restrictions prohibiting aircraft from flying within 1,000 ft (305 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea; and

(6) No routine vessel traffic will traverse the subsistence area. Vessels within 900 ft (274 m) of marine mammals will reduce speed, avoid separating members from a group, and avoid multiple changes in direction.

For several years, a Conflict Avoidance Agreement (CAA) has been negotiated between the AEWC, affected whaling captains' associations, and the oil and gas industry to avoid conflicts between industry activity and bowhead whale subsistence hunts. While the signing of a CAA is not a requirement to obtain an IHA, often times, the CAA contains measures that help NMFS make its no unmitigable adverse impact determination for bowhead whales. Shell is currently reviewing the draft 2010 CAA and is expected to make a decision on whether or not it will sign the 2010 CAA prior to commencing operations this year.

Unmitigable Adverse Impact Analysis and Preliminary Determination

NMFS has preliminarily determined that Shell's proposed Camden Bay exploration drilling program will not have an unmitigable adverse impact on the availability of species or stocks for taking for subsistence uses. This preliminary determination is supported by information contained in this document and Shell's POC. Shell has adopted a spatial and temporal strategy for its Camden Bay operations that should minimize impacts to subsistence hunters. First, Shell's activities will not commence until after the spring hunts have occurred. Additionally, Shell will traverse the Chukchi Sea far offshore, so as to not interfere with July hunts in the Chukchi Sea and will communicate with the Com Centers to notify local communities of any changes in the transit route. Once Shell is on location in Camden Bay, Beaufort Sea, whaling will not commence until late August/ early September. Shell has agreed to cease operations on August 25 to allow the villages of Kaktovik and Nuiqsut to prepare for the fall bowhead hunts, will move the drillship and all support vessels out of the hunting area so that there are no physical barriers between the marine mammals and the hunters, and will not recommence activities until the close of both villages' hunts.

Kaktovik is located 60 mi (96.6 km) east of the project area. Therefore, westward migrating whales would reach Kaktovik before reaching the area of Shell's activities or any of the ensonified zones. Although Cross Island and Barrow are west of Shell's drill sites, sound generating activities from Shell's drilling program will have ceased prior to the whales passing through the area. Additionally, Barrow lies 298 mi (479.6 km) west of Shell's Camden Bay drill sites, so whalers in that area would not be displaced by any of Shell's activities.

Adverse impacts are not anticipated on sealing activities since the majority of hunts for seals occur in the winter and spring, when Shell will not be operating. Sealing activities in the Colville River delta area occur more than 100 mi (161 km) from Shell's Camden Bay drill sites.

Shell will also support the village Com Centers in the Arctic communities and employ local Subsistence Advisors from the Beaufort and Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunt. The Subsistence Advisors will provide advice to Shell on ways to minimize and mitigate potential impacts to subsistence resources during the drilling season.

Based on the measures described in Shell's Draft POC, the proposed mitigation and monitoring measures (described earlier in this document), and the project design itself, NMFS has determined preliminarily that there will not be an unmitigable adverse impact on subsistence uses from Shell's Camden Bay exploration drilling activities.

Endangered Species Act (ESA)

There is one marine mammal species listed as endangered under the ESA with confirmed or possible occurrence in the proposed project area: The bowhead whale. NMFS' Permits, Conservation and Education Division has initiated consultation with NMFS' Endangered Species Division under section 7 of the ESA on the issuance of an IHA to Shell 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 preparing an Environmental Assessment, pursuant to NEPA, to determine whether or not this proposed activity may have a significant effect on the human environment. This analysis will be completed prior to the issuance or denial of the IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to authorize the take of marine mammals incidental to Shell's 2010 Camden Bay, Beaufort Sea, Alaska, exploration drilling program, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: April 12, 2010.

James H. Lecky,

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

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