DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XV09

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Open Water Marine Seismic Survey in the Beaufort and Chukchi Seas, Alaska

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

ACTION: Notice; issuance of an incidental take authorization.

SUMMARY: In accordance with the Marine Mammal Protection Act (MMPA) regulations, notification is hereby given that NMFS has issued an Incidental Harassment Authorization (IHA) to Shell Offshore Inc. (Shell) to take, by harassment, small numbers of 8 species of marine mammals incidental to a marine survey program, which includes site clearance and shallow hazards, ice gouge, and strudel scour surveys, in the Beaufort and Chukchi Seas, Alaska, during the 2010 Arctic open water season.

DATES: Effective August 6, 2010, through November 30, 2010.

ADDRESSES: Inquiry for information on the incidental take authorization 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. A copy of the application containing a list of the references used in this document, NMFS' Environmental Assessment (EA) and Finding of No Significant Impact (FONSI), and the IHA 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#applications.*

Documents cited in this notice may be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Shane Guan, Office of Protected Resources, NMFS, (301) 713–2289 or Brad Smith, NMFS, Alaska Region, (907) 271–3023.

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. 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"].

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.

Summary of Request

NMFS received an application on December 24, 2009, from Shell for the taking, by harassment, of marine mammals incidental to several marine surveys designed to gather data relative to site clearance and shallow hazards, ice gouge, and strudel scour in selected areas of the Beaufort Sea and ice gouge in the Chukchi Sea, Alaska. These surveys are continuations of those performed by Shell in the Beaufort Sea beginning in 2006, and in the Chukchi Sea in 2008. After addressing comments from NMFS, Shell modified its application and submitted a revised application on April 19, 2010. The April 19, 2010, application is the one available for public comment (*see* **ADDRESSES**) and considered by NMFS for this proposed IHA.

Site clearance and shallow hazards surveys will evaluate the seafloor, and shallow sub seafloor at prospective exploration drilling locations, focusing on the depth to seafloor, topography, the potential for shallow faults or gas zones, and the presence of archaeological features. The types of equipment used to conduct these surveys use low level energy sources focused on limited areas in order to characterize the footprint of the seafloor and shallow sub seafloor at prospective drilling locations. Ice gouge surveys will determine the depth and distribution of ice gouges into the seabed. Ice gouge surveys use low-level energy sources similar to the site clearance and shallow hazards.

Shell intends to conduct these marine surveys during the 2010 Arctic open-water season (July through October). Impacts to marine mammals may occur from noise produced by various active acoustic sources used in the surveys.

Description of the Specified Activity

Shell plans to complete the following surveys during the 2010 open-water season:

- Beaufort Sea Site Clearance and Shallow Hazards Surveys
- Beaufort Sea Marine Surveys
  - Ice Gouge Survey
  - Strudel Scour Survey
- Chukchi Sea Marine Surveys
  - Ice Gouge Survey

Each of these individual surveys will require marine vessels to accomplish the work. Shell states that these marine surveys will be conducted between July and October 2010, however, ice and weather conditions will influence the exact dates and locations marine vessel survey operations can be conducted.

1. Beaufort Sea Site Clearance and Shallow Hazards Surveys

Shell's proposed site clearance and shallow hazards surveys are to gather data on: (1) Bathymetry, (2) seabed topography and other seabed characteristics (*e.g.,* boulder patches), (3) potential geohazards (*e.g.,* shallow faults and shallow gas zones), and (4) the presence of any archeological features (*e.g.,* shipwrecks). Site clearance and shallow hazards surveys can be accomplished by one vessel with

acoustic sources. No other vessels are necessary to accomplish the proposed work.

The focus of this activity will be on Shell's existing leases in Harrison Bay in the central Beaufort Sea. Actual locations of site clearance and shallow hazards surveys within Harrison Bay have not been definitively set as of this date, although these will occur on the Outer Continental Shelf (OCS) lease blocks in Harrison Bay located in the Beaufort Sea shown on Figure 1 of Shell's IHA application. The site clearance and shallow hazards surveys will be conducted within an area of approximately 216 mi^2 (558 km^2) north of Thetis Island more than 3 mi (4.8 km) to approximately 20 mi (33 km) offshore. Approximately 63 mi (162.7 km) of the data acquisition is planned within this general area. The survey track line is approximately 351.5 mi^2 (565 km^2). The average depth of the survey area ranges from 35 to 85 ft (10.7 to 26 m).

Ice and weather permitting, Shell is proposing to conduct site clearance and shallow hazards surveys within the timeframe of July 2010 through October 2010. The actual survey time is expected to take 30 days.

The vessel that will be conducting this activity has not been determined at this point, but will be similar to the R/V *Mt. Mitchell* which is the vessel that was used for surveys in the Chukchi Sea in 2009. The R/V *Mt. Mitchell* is a diesel powered-vessel, 70 m (231 ft) long, 12.7 m (42 ft) wide, with a 4.5 m (15 ft) draft.

It is proposed that the following acoustic instrumentation, or something similar, be used.

• Deep Penetration Profiler, (40 cu-in airgun source with 48-channel streamer) and Medium Penetration Profiler, (40 cu-in airgun source with 24-channel streamer):

The deep and medium penetration profilers are the major active acoustic sources used in the site clearance and shallow hazards surveys. The modeled source level is estimated at 217 dB re 1 µPa rms. The 120, 160, 180, and 190 dB re 1 µPa rms received level isopleths are estimated at 14,900 m, 1,220 m, 125 m, and 35 m from the source, respectively.

• Dual-frequency side scan sonar, (100–400 kHz or 300–600 kHz):

Based on Shell's 2006 90-day report, the source level of this active acoustic source when operated at 190 and 240 kHz is approximately 225 dB re 1 µPa rms. Due to its high frequency range, NMFS does not consider its acoustic energy would be strong enough to cause impacts to marine mammals beyond a couple of hundred meters from the source.

• Single beam Echo Sounder, (high: 100–340 kHz, low: 24–50 kHz):

This echo sounder is a typical "fathometer" or "fish-finder" that is widely used in most recreational or fishing vessels. Source levels for these types of units are typically in the range of 180–200 dB re 1 µPa rms. Using a spherical spreading model, the 160 dB isopleth is estimated at 100 m from the source for the lower range of the acoustic signals. For the higher range of the signal, due to the higher absorption coefficients, the 160 dB isopleth is expected to be under 100 m from the source.

• Multi-Beam Echo Sounder, (240 kHz):

Since the output frequency from this echo sounder is above the upper-limit of marine mammal hearing range, NMFS believes it unlikely that a marine mammal would be taken by this activity.

• Shallow Sub-Bottom Profiler, (2–12 kHz):

Information regarding this active acoustic source on two vessels (*Alpha Helix* and *Henry C.*) was provided in Shell's 2008 90-day open water marine survey monitoring report. For the *Alpha Helix* measurement, at 3.5 kHz, the source level for the shallow sub-bottom profiler was 193.8 dB re 1 µPa rms, and its 120, 160, 180, and 190 dB re 1 µPa rms isopleths were determined to be 310 m, 14 m, 3 m, and 1 m from the source, respectively. For the *Henry C.* measurement, at 3.5 kHz, the source level of the similar profiler was measured at 167.2 dB re 1 µPa rms, and its 120 and 160 dB re 1 µPa rms isopleths were determined to be 980 m and 3 m, respectively.

2. Beaufort Sea Marine Surveys

Two marine survey activities are proposed for the Beaufort Sea: (1) Ice gouge survey, and (2) strudel scour survey. Shell continues to conduct these types of marine surveys annually over a few years to enhance baseline and statistical understanding of the formation, longevity, and temporal distribution of sea floor features and baseline environmental and biologic conditions. Marine surveys for ice gouge and strudel scour surveys can be accomplished by one vessel for each. No other vessels are necessary to accomplish the proposed work.

The proposed ice gouge surveys will be conducted in both State of Alaska waters including Camden Bay, and the Federal waters of the OCS in the Beaufort Sea near Pt. Thomson ranging from near shore to approximately 37 mi (59.5 km) offshore. The water depth in the ice gouging survey area ranges between 15 to 120 ft (4.5 to 36.6 m), and the surveys will be conducted within an area of 1,950 mi^2 (5,036 km^2) with a survey track line of approximately 1,276 mi (2,050 km, *See* Figure 2 of Shell's IHA application).

The proposed strudel scour survey will occur in State of Alaska waters in Pt. Thomson ranging from near shore to 3 mi (4.8 km) offshore. The water depth ranges from 3 to 20 ft (0.9 to 6.1 m). The strudel scour survey will be conducted in an area of approximately 140 mi^2 (361.5 km^2). The survey track line is approximately 124 mi (200 km).

Ice and weather permitting, Shell is proposing to conduct this work within the timeframe of July 2010 through October 2010. The actual survey time is expected to take 45 days.

Ice Gouge Survey

As part of the feasibility study for Shell's Alaskan prospects a survey is required to identify and evaluate seabed conditions. Ice gouging is created by ice keels, which project from the bottom of moving ice and gouge into seafloor sediment. Ice gouge features are mapped, and by surveying each year, new gouges can be identified. The ice gouge information is used to aid in predicting the prospect of, orientation, depth, and frequency of future ice gouges. Ice gouge information is required for the design of potential pipelines and for the design of pipeline trenching and installation equipment.

The 2010 ice gouge surveys will be conducted using the conventional survey method where the acoustic instrumentation will be towed behind the survey vessel, or possibly with the use of an Autonomous Underwater Vehicle (AUV). The same acoustic instrumentation will be used during both AUV and the conventional survey methods. The AUV is a self-propelled autonomous vehicle that will be equipped with acoustic instrumentation and programmed for remote operation over the seafloor where the ice gouge survey is to be conducted, and the vehicle is launched and retrieved from a marine vessel.

For the survey operations, the AUV will be launched from the stern of a vessel and will survey the seafloor close to the vessel. The vessel will transit an area, with the AUV surveying the area behind the vessel. The AUV also has a Collision Avoidance System and operates without a towline that reduces potential impact to marine mammals (such as entanglement). Using bathymetric sonar or multibeam echo sounder the AUV can record the gouges on the seafloor surface caused by ice keels. The sub-bottom profiler can

record layers beneath the surface to about 20 feet (6 m). The AUV is more maneuverable and able to complete surveys more quickly than a conventional survey. This reduces the duration that vessels producing sound must operate. The proposed ice gouge survey in the Beaufort Sea is expected to last for 45 days.

The vessel that will be used for ice gouging surveys has not been selected, but it is anticipated that the vessel would be similar to the R/V *Mt. Mitchell,* which is 70 m (231 ft) long, 12.7 m (42 ft) wide, and 4.5 m (15 ft) draft.

It is proposed that the following acoustic instrumentation, or something similar, be used.

• Dual Frequency sub-bottom profiler; (2 to 7 kHz or 8 to 23 kHz):

Information regarding this active acoustic source on *Henry C.* was provided in Shell's 2006 and 2007 90-day open water marine survey monitoring reports. In the 2006 report, at 2–7 and 8–23 kHz, the source level was estimated at 184.6 dB re 1 μPa rms, and its 120, 160, and 180 dB re 1 μPa rms isopleths were determined to be 456 m, 7 m, and 2 m from the source, respectively. In the 2007 report, at 2–7 kHz, the source level was estimated at 161.1 dB re 1 μPa rms, and its 120 and 160 dB re 1 μPa rms isopleths were determined to be 260 m and 1 m, respectively.

• Multibeam Echo Sounder (240 kHz) and Side-scan sonar system (190 to 210 kHz):

Since the output frequencies from these acoustic instruments are above the upper-limits of marine mammal hearing range, NMFS believes it unlikely that a marine mammal would be taken by this activity.

Strudel Scour Survey

During the early melt on the North Slope, the rivers begin to flow and discharge water over the coastal sea ice near the river deltas. That water flows down holes in the ice ("strudels") and scours the seafloor. These areas are called "strudel scours". Information on these features is required for prospective pipeline planning. Two proposed activities are required to gather this information: aerial survey via helicopter overflights during the melt to locate the strudels; and strudel scour marine surveys to gather bathymetric data. The overflights investigate possible sources of overflood water and will survey local streams that discharge in the vicinity of Point Thomson including the Staines River, which discharges to the east into Flaxman Lagoon, and the Canning River, which discharges to the east directly into the Beaufort Sea. These helicopter overflights will occur during late May/early June 2010 and, weather permitting, should take no more than two days. There are no planned landings during these overflights other than at the Deadhorse or Kaktovik airports.

Areas that have strudel scour identified during the aerial survey will be verified and surveyed with a marine vessel after the breakup of nearshore ice. The vessel has not been determined, however, it is anticipated that it will be the diesel-powered R/V *Annika Marie* which has been utilized 2006 through 2008 and measures 13.1 m (43 ft) long, or similar vessel.

This proposed activity is not anticipated to take more than 5 days to conduct. The operation is conducted in the shallow water areas near the coast in the vicinity of Point Thomson. This vessel will use the following equipment:

• Multibeam Echo Sounder (240 kHz) and Side-scan sonar system (190 to 210 kHz):

Since the output frequencies from these acoustic instruments are above the upper-limits of marine mammal hearing range, NMFS believes it unlikely that a marine mammal would be taken by this activity.

• Single Beam Bathymetric Sonar:

Source levels for these types of units are typically in the 180–230 dB range, somewhat lower than multibeam or side scan sonars. A unit used during a previous survey had a source level (at high power) of 215 dB re 1 μPa (0-peak) and a standard operating frequency of 200 kHz. Since the output frequencies from these acoustic instruments are above the upper-limits of marine mammal hearing range, NMFS believes it unlikely that a marine mammal would be taken by this activity.

3. Chukchi Sea Marine Survey—Ice Gouge Survey

Shell proposes one marine survey activity for the Chukchi Sea in 2010. Shell intends to conduct ice gouge surveys annually over a few years to enhance baseline and statistical understanding of the formation, longevity, and temporal distribution of sea floor features and baseline environmental and biologic conditions. The ice gouge survey can be accomplished by one vessel. No other vessels are necessary to accomplish the proposed work.

The proposed ice gouge surveys will be conducted in both State of Alaska waters and the Federal waters of the OCS in the Chukchi Sea. Actual locations of the ice gouge surveys have not been definitively set as of this date, although these will occur within the area outlined in Figure 4 of the IHA application. The water depth of the ice gouging survey ranges between 20 to 120 ft (6.1 to 36.6 m), and the surveys will take in an area of 21,954 mi^2 (56,965 km^2), with a survey track line of approximately 1,539 mi (2,473 km). This activity is proposed to be conducted within the timeframe of July through October 2010. The total program will last a maximum of 60 days, excluding downtime due to ice, weather and other unforeseen delays, and should be complete by the end of October 2010.

The equipment and method used to conduct the ice gouge survey in the Chukchi Sea will be the same as that used in the Beaufort Sea. Because of the low source levels of the sub-bottom profiler and the high-frequency nature of the multi-beam echo sounder used in the proposed ice gouge survey, NMFS believes it unlikely that a marine mammal would be taken by this activity.

Comments and Responses

A notice of NMFS' proposal to issue an IHA to Shell published in the **Federal Register** on May 18, 2010 (75 FR 27708). That notice described, in detail, Shell's proposed activity, the marine mammal species that may be affected by the activity, and the anticipated effects on marine mammals. During the 30-day public comment period, NMFS received five comment letters from the following: the Marine Mammal Commission (Commission); the Alaska Eskimo Whaling Commission (AEWC); the Inupiat Community of the Arctic Slope (ICAS); the North Slope Borough Office of the Mayor (NSB); and Alaska Wilderness League (AWL), Audubon Alaska, Center for Biological Diversity, Defenders of Wildlife, Earthjustice, Greenpeace, Natural Resources Defense Council, Northern Alaska Environmental Center, Ocean Conservancy, Oceana, Pacific Environment, Sierra Club, and World Wildlife Fund (collectively "AWL"), along with an attached letter from Dr. David E. Bain, a contract scientist for NMFS.

The AEWC submitted several journal articles as attachments to its comment letters. NMFS acknowledges receipt of these documents but does not intend to address the specific articles themselves in the responses to comments, since these journal articles are merely used as citations in AEWC's comments. AEWC also submitted an unsigned, final version of the 2010 Conflict Avoidance Agreement (CAA), since Shell declined to sign the CAA. Dr. Bain also attached

an in-review journal article he coauthored. Any comments specific to Shell's application that address the statutory and regulatory requirements or findings NMFS must make to issue an IHA are addressed in this section of the **Federal Register** notice.

General Comments

Comment 1: AEWC and ICAS believe that NMFS should not issue incidental take authorizations for oil and gas-related activities given the current suspension of offshore drilling in Alaska and pending reorganization of the Minerals Management Service (MMS). AEWC and ICAS point out that the harm caused by an oil spill is not the only risk to marine mammals posed by oil and gas activities on the OCS and that there are concerns regarding underwater noise from geophysical activities and the threats posed to marine mammals from noise and chemical pollution, as well as increased vessel traffic. AEWC further claims that many times, NMFS issued IHAs over the objections of the scientific and subsistence communities as well as the agencies' own scientists.

Response: The legal requirements and underlying analysis for the issuance of an IHA concerning take associated with seismic activities are unrelated to the moratorium on offshore drilling and reorganization of the MMS. In order to issue an authorization pursuant to Section 101(a)(5)(D) of the MMPA, NMFS must determine that the taking by harassment of small numbers of marine mammal species or stocks will have a negligible impact on affected species or stocks, and will not have an unmitigable adverse impact on the availability of affected species or stocks for taking for subsistence uses. If NMFS is able to make these findings, the Secretary is required to issue an IHA. In the case of Shell's activities for 2010 (as described in the application, the notice of proposed IHA (75 FR 27708; May 18, 2010) and this document), NMFS determined that it was able to make the required MMPA findings. Additionally, as described later in this section and throughout this document, NMFS has determined that Shell's activities will not result in injury or mortality of marine mammals, and no injury or mortality is authorized under the IHA.

As discussed in detail in the proposed IHA (75 FR 27708; May 18, 2010), the EA for the issuance of IHAs to Shell and Statoil for the proposed open water marine and seismic surveys, and this document, NMFS has conducted a thorough analysis of the potential impacts of underwater anthropogenic sound (especially sound from geophysical surveys) on marine mammals. We have cited multiple studies and research that support NMFS' MMPA and National Environmental Policy Act (NEPA) determinations that the localized and short-term disturbance from seismic surveys, with strict mitigation and monitoring measures implemented, is likely to result in negligible impacts to marine mammals and no significant impact to the human environment, respectively. Although issuance of the IHA may be of concern to certain members of the public, the proposed issuance of the IHA was carefully reviewed and analyzed by NMFS scientists both at headquarters, through an Endangered Species Act (ESA) section 7 consultation at NMFS Alaska Regional Office, and by an independent bioacoustics expert and NMFS' National Marine Mammal Laboratory. Based on those reviews, NMFS staff in the Office of Protected Resources made appropriate changes to this document.

Comment 2: ICAS points out that Native communities in Alaska have long been ignored in the race to find and develop offshore oil and gas resources and that the U.S. Government has consistently failed to comply with legal requirements that require consultation with local Native communities as proposals are being developed that affect native environments. Instead, both Federal agencies and the entities they permit make only token gestures at consultations with Native groups offering them only the opportunity for involvement after proposals are developed and after local knowledge would serve a useful purpose.

Response: Regulations at 50 CFR 216.104(a)(12) require applicants for IHAs in Arctic waters to submit a Plan of Cooperation (POC), which, among other things, requires the applicant to meet with affected subsistence communities to discuss the proposed activities. Additionally, for many years, NMFS has conducted the Arctic Open Water Meeting, which brings together the Federal agencies, the oil and gas industry, and affected Alaska Native organizations to discuss the proposed activities and monitoring plans. Local knowledge is considered at these times, and it is not too late for that knowledge to serve a useful purpose. These communities are also afforded the opportunity to submit comments on the application and proposed IHA notice, which are then considered by NMFS before making a final determination on whether or not to issue an IHA.

Comment 3: Executive Order 13175 requires Federal agencies to conduct government-to-government consultation when undertaking to formulate and implement policies that have tribal implications. Despite this explicit requirement, ICAS believes that NMFS has failed to consult with governing bodies of Native people who will be and have been affected by the decisions NMFS is making under the MMPA. NMFS must meet with ICAS and local Native villages on a government-to-government basis to discuss the proposed IHA, as well as appropriate mitigation and monitoring requirements.

Response: NMFS recognizes the importance of the government-to-government relationship and has taken steps to ensure that Alaska Natives play an active role in the management of Arctic species. For example, NOAA and the AEWC co-manage bowhead whales pursuant to a cooperative agreement. This agreement has allowed the AEWC to play a significant role in the management of a valuable resource by affording Alaska Natives the opportunity to protect bowhead whales and the Eskimo culture and to promote scientific investigation, among other purposes.

In addition, NMFS works closely with Alaska Natives when considering whether to permit the take of marine mammals incidental to oil and gas operations. NMFS has met repeatedly over the years with Alaska Native representatives to discuss concerns related to NMFS' MMPA program in the Arctic, and has also taken into account recommended mitigation measures to reduce the impact of oil and gas operations on bowhead whales and to ensure the availability of marine mammals for taking for subsistence uses. Finally, NMFS has participated in Alaska Native community meetings in the past and will continue to do so, when feasible. NMFS most recently met with ICAS at its May monthly meeting in Barrow to discuss NMFS' role in minimizing impacts to marine mammals from oil and gas industry activities and asked the ICAS membership for specific recommendations. NMFS will continue to ensure that it meets its government-to-government responsibilities and will work closely with Alaska Natives to address their concerns.

MMPA Concerns

Comment 4: AEWC notes their disappointment in NMFS for releasing for public comment an incomplete application from Shell that fails to provide the mandatory information required by the MMPA and NMFS' implementing regulations. AEWC requests that NMFS return Shell's application as incomplete, or else the agency risks making arbitrary and

indefensible determinations under the MMPA. The following is the information that AEWC believes to be missing from Shell's application: (1) A description of the "age, sex, and reproductive condition" of the marine mammals that will be impacted, particularly in regard to bowhead whales (50 CFR 216.104(a)(6)); (2) the economic "availability and feasibility * * * of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance" (50 CFR 216.104(a)(11)); and (3) suggested means of learning of, encouraging, and coordinating any research related activities (50 CFR 216.104(a)(14)). NSB also notes its concern about the lack of specificity regarding the timing and location of the proposed surveys, as well as the lack of specificity regarding the surveys themselves.

Response: NMFS does not agree that it released an incomplete application for review during the public comment period. After NMFS' initial review of the application, NMFS submitted questions and comments to Shell on its application. After receipt and review of Shell's responses, which were incorporated into the final version of the IHA application that was released to the public for review and comment, NMFS made its determination of completeness and released the application, addenda, and the proposed IHA notice (75 FR 27708; May 18, 2010). Regarding the three specific pieces of information believed to be missing by AEWC, Shell's original application included a description of the pieces of information that are required pursuant to 50 CFR 216.104(a)(12).

Information required pursuant to 50 CFR 216.104(a)(6) requires that an applicant submit information on the "age, sex, and reproductive condition (if possible)" of the number of marine mammals that may be taken. In the application, Shell described the species expected to be taken by harassment and provided estimates of how many of each species were expected to be taken during their activities. In most cases, it is very difficult to estimate how many animals, especially cetaceans, of each age, sex, and reproductive condition will be taken or impacted by seismic or site clearance and shallow hazards surveys.

Shell also provided information on economic "availability and feasibility * * * of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance" (50 CFR 216.104(a)(11)) in its IHA application. In its application, Shell states that four main mitigations regarding site clearance and shallow hazards surveys in the Beaufort Sea are proposed: (1) Timing and locations for active survey acquisition work; (2) to configure airguns in a manner that directs energy primarily down to the seabed thus decreasing the range of horizontal spreading of noise; (3) using a energy source which is as small as possible while still accomplishing the survey objectives; and (4) curtailing active survey work when the marine mammal observers sight visually (from shipboard) the presence of marine mammals within identified ensonified zones. Details of these mitigation measures are discussed further in the 4MP that is included in Shell's IHA application. In addition to these measures, NMFS' Notice of Proposed IHA (75 FR 27708, May 18, 2010) described mitigation measures proposed to be implemented by Shell (outlined in the application), as well as additional measures proposed by NMFS for inclusion in an IHA.

Lastly, information required pursuant to 50 CFR 216.104(a)(14) was also included in Shell's application. Shell provided a list of researchers who could potentially receive results of their research activities who may find the data useful in their own research. Additionally, Shell states that it plans to deploy arrays of acoustic recorders in the Beaufort Sea in 2010, similar to those deployed in 2007 and 2008 using DASARs supplied by Greeneridge. These directional acoustic systems permit localization of bowhead whale and other marine mammal vocalizations, and to further understand, define, and document sound characteristics and propagation resulting from shallow hazards surveys that may have the potential to cause deflections of bowhead whales from their migratory pathway. NMFS also determined that Shell's application provides descriptions of the specified activities and specified geographic region.

In conclusion, NMFS believes that Shell provided all of the necessary information to proceed with publishing a proposed IHA notice in the **Federal Register**.

Comment 5: AEWC and NSB state that NMFS failed to issue a draft authorization for public review and comment. The plain language of both the MMPA and NMFS' implementing regulations require that NMFS provide the opportunity for public comment on the "proposed incidental harassment authorization" (50 CFR 216.104(b)(1)(i); 16 U.S.C. 1371 (a)(5)(D)(iii)) and not just on the application itself as NMFS has done here. Given Shell's refusal to sign the CAA and without a complete draft authorization and accompanying findings, AEWC states that it cannot provide meaningful comments on Shell's proposed activities, ways to mitigate the impacts of those activities on marine mammals, and measures that are necessary to protect subsistence uses and sensitive resources.

Response: The May 18, 2010 proposed IHA notice (75 FR 27708) contained all of the relevant information needed by the public to provide comments on the proposed authorization itself. The notice contained the permissible methods of taking by harassment, means of effecting the least practicable impact on such species (*i.e.,* mitigation), measures to ensure no unmitigable adverse impact on the availability of the species or stock for taking for subsistence use, requirements pertaining to the monitoring and reporting of such taking, including requirements for the independent peer review of the proposed monitoring plan. The notice provided detail on all of these points and, in NMFS view, allowed the public to comment on the proposed authorization and inform NMFS' final decision. Additionally, the notice contained NMFS' preliminary findings of negligible impact and no unmitigable adverse impact.

The signing of a CAA is not a requirement to obtain an IHA. The CAA is a document that is negotiated between and signed by the industry participant, AEWC, and the Village Whaling Captains' Associations. NMFS has no role in the development or execution of this agreement. Although the contents of a CAA may inform NMFS' no unmitigable adverse impact determination for bowhead and beluga whales and ice seals, the signing of it is not a requirement. While a CAA has not been signed and a final version agreed to by industry participants, AEWC, and the Village Whaling Captains' Associations, NMFS was provided with a copy of the version ready for signature by AEWC. NMFS has reviewed the CAA and included several measures from the document which relate to marine mammals and avoiding conflicts with subsistence hunts in the IHA. Some of

the conditions which have been added to the IHA include: (1) Avoiding concentrations of whales and reducing vessel speed when near whales; (2) flying at altitudes above 457 m (1,500 ft) unless involved in marine mammal monitoring or during take-offs, landings, or in emergencies situations; (3) conducting sound source verification measurements; and (4) participating in the Communication Centers. Despite the lack of a signed CAA for 2010 activities, NMFS is confident that the measures contained in the IHA will ensure no unmitigable adverse impact to subsistence users.

Comment 6: AEWC and NSB argue that Shell has not demonstrated that its proposed activities would take only "small numbers of marine mammals of a species or population stock," resulting in no more than a "negligible impact" on a species or stock. In addition, NSB argues that NMFS has not adequately analyzed harassment associated with received levels of noise below 160 dB.

Response: NMFS believes that it provided sufficient information in its proposed IHA notice (75 FR 27708; May 18, 2010) to make the small numbers and negligible impact determinations and that the best scientific information available was used to make those determinations. While some published articles indicate that certain marine mammal species may avoid seismic vessels at levels below 160 dB, NMFS does not consider that these responses rise to the level of a take, as defined in the MMPA. While studies, such as Miller *et al.* (1999), have indicated that some bowhead whales may have started to deflect from their migratory path 35 km (21.7 mi) from the seismic vessel, it should be pointed out that these minor course changes are during migration and, as described in MMS' 2006 Final Programmatic Environmental Assessment (PEA), have not been seen at other times of the year and during other activities. To show the contextual nature of this minor behavioral modification, recent monitoring studies of Canadian seismic operations indicate that feeding, non-migratory bowhead whales do not move away from a noise source at an SPL of 160 dB. Therefore, while bowheads may avoid an area of 20 km (12.4 mi) around a noise source, when that determination requires a post-survey computer analysis to find that bowheads have made a 1 or 2 degree course change, NMFS believes that does not rise to a level of a "take," as the change in bearing is due to animals sensing the noise and avoiding passage through the ensonified area during their migration, and should not be considered as being displaced from their habitat. NMFS therefore continues to estimate "takings" under the MMPA from impulse noises, such as seismic, as being at a distance of 160 dB (re 1 μPa). As explained throughout this **Federal Register** notice, it is highly unlikely that marine mammals would be exposed to SPLs that could result in serious injury or mortality. The best scientific information indicates that an auditory injury is unlikely to occur, as apparently sounds need to be significantly greater than 180 dB for injury to occur (Southall *et al.,* 2007). The 180–dB radius for the airgun array to be used by Shell is 125 m (410 ft). Therefore, if injury were possible from Shell's activities, the animal would need to be closer than 125 m (410 ft). However, based on the configuration of the airgun array and streamers, it is highly unlikely that a marine mammal would be that close to the seismic vessel. Mitigation measures described later in this document will be implemented should a marine mammal enter this small zone around the airgun array.

Regarding the "small numbers" issue raised by the AEWC and NSB, NMFS has provided estimates on the number of marine mammals that could be taken as a result of Shell's proposed marine surveys, and the estimated takes from these proposed activities are all under 3 percent for affected marine mammal populations (*see* Potential Number of Takes by Harassment section below).

Impacts to Marine Mammals

Comment 7: AEWC notes that based on the density estimates, Shell is predicting that an average of 381 and a maximum of 394 Bering-Chukchi-Beaufort (B–C–B) stock of bowhead whales may be exposed to seismic sounds at received levels above 160 dB. AEWC states that these are by no means "small numbers" of marine mammals that will be subjected to impacts as a result of Shell's operations.

Response: NMFS determined that the small numbers requirement has been satisfied. Shell has predicted that an average of 381 individuals of the B–C–B stock of bowhead whales would be exposed to noise received levels above 160 dB as the result of Shell's proposed marine surveys, and NMFS assumes that animals exposed to received levels above 160 dB are taken. However, because of the tendency of whales to avoid the source to some degree, and the fact that both the whales and the source are both moving through an area, the majority of the exposures would likely occur at levels closer to 160 dB (not higher levels) and the impacts would be expected to be relatively low-level and not of a long duration. NMFS addresses "small numbers" in terms relative to the stock or population size. The Level B harassment take estimate of 381 bowhead whales is a small number in relative terms, because of the nature of the anticipated responses and in that it represents only 2.67 percent of the regional stock size of that species (14,247), if each "exposure" at 160 dB represents an individual bowhead whale. Additionally, the percentage would be even lower if animals move out of the seismic area in a manner that does not result in a take at all.

Comment 8: AWL, NSB, and AEWC noted that NMFS has acknowledged that permanent threshold shift (PTS) qualifies as a serious injury. Therefore, if an acoustic source at its maximum level has the potential to cause PTS and thus lead to serious injury, it would not be appropriate to issue an IHA for the activity (60 FR 28381, May 31, 1995). AEWC states that therefore an LOA is required here. While the airguns proposed by Shell are smaller than those associated with typical 2D/3D deep marine surveys, the noise they produce is still considerable, as evidenced by the estimated 120 dB radius that extends out to 14,000 m.

Response: In the proposed rule to implement the process to apply for and obtain an IHA, NMFS stated that authorizations for harassment involving the "potential to injure" would be limited to only those that may involve non-serious injury (60 FR 28379; May 31, 1995). While the **Federal Register** notice cited by the commenters states that NMFS considered PTS to be a serious injury (60 FR 28379; May 31, 1995), our understanding of anthropogenic sound and the way it impacts marine mammals has evolved since then, and NMFS no longer considers PTS to be a serious injury. NMFS has defined "serious injury" in 50 CFR 216.3 as "* * * any injury that will likely result in mortality." There are no data that suggest that PTS would be likely to result in mortality, especially the limited degree of PTS that could hypothetically be incurred through exposure of marine mammals to seismic airguns at the level and for the duration that are likely to occur in this action.

Further, as stated several times in this document and previous **Federal Register** notices for seismic activities, there is no empirical evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns (*see* Southall *et al.* 2007). PTS is thought to occur several decibels above that inducing mild temporary threshold shift (TTS), the mildest form of hearing impairment (a non-injurious effect).

NMFS 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 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. As summarized later in this document, data that are now available imply that TTS is unlikely to occur unless bow-riding odontocetes are exposed to airgun pulses much stronger than 180 dB re 1 Pa rms (Southall *et al.* 2007). Additionally, NMFS has required monitoring and mitigation measures to negate the possibility of marine mammals being seriously injured as a result of Shell's activities. In the proposed IHA, NMFS determined that Shell's activities are unlikely to even result in TTS. Based on this determination and the explanation provided here, PTS is also not expected. Therefore, an IHA is appropriate.

Comment 9: AWL, Dr. Bain, NSB, and AEWC state that NMFS has not adequately considered whether marine mammals may be harassed at received levels significantly lower than 160 dB and that NMFS did not use the best scientific evidence in setting the sound levels against which take was assessed. They state that NMFS calculated harassment from Shell's proposed surveying based on the exposure to marine mammals to sounds at or above 160 dB and that this uniform approach to harassment does not take into account known reactions of marine mammals in the Arctic to levels of noise far below 160 dB. These comments state that bowhead, gray, killer, and beluga whales and harbor porpoise react to sounds lower than 160 dB.

Citing several papers on killer whales and harbor porpoise, Dr. Bain states that major behavioral changes of these animals appear to be associated with received levels of around 135 dB re 1 µPa, and that minor behavioral changes can occur at received levels from 90–110 dB re 1 µPa or lower. He also states that belugas have been observed to respond to icebreakers by swimming rapidly away at distances up to 80 km, where received levels were between 94 and 105 dB re 1 µPa. Belugas exhibited minor behavioral changes such as changes in vocalization, dive patterns, and group composition at distances up to 50 km (NRC 2003), where received levels were likely around 120 dB.

AEWC also states that in conducting scoping on its national acoustic guidelines for marine mammals, NMFS noted that the existing system for determining take (*i.e.,* the 160 dB mark) "considers only the sound pressure level of an exposure but not its other attributes, such as duration, frequency, or repetition rate, all of which are critical for assessing impacts on marine Mammals" and "also assumes a consistent relationship between rms (root-mean-square) and peak pressure values for impulse sounds, which is known to be inaccurate under certain (many) conditions" (70 FR 1871, 1873; January 11, 2005). Thus, NMFS itself has recognized that 160 dB (rms) is not an adequate measure. AEWC argues that current scientific research establishes that 120 dB (rms) is a more appropriate measure for impacts to marine mammals.

Response: The best information available to date for reactions by bowhead whales to noise, such as seismic, is based on the results from the 1998 aerial survey (as supplemented by data from earlier years) as reported in Miller *et al.* (1999). In 1998, bowhead whales below the water surface at a distance of 20 km (12.4 mi) from an airgun array received pulses of about 117–135 dB re 1 µPa rms, depending upon propagation. Corresponding levels at 30 km (18.6 mi) were about 107–126 dB re 1 µPa rms. Miller *et al.* (1999) surmise that deflection may have begun about 35 km (21.7 mi) to the east of the seismic operations, but did not provide SPL measurements to that distance and noted that sound propagation has not been studied as extensively eastward in the alongshore direction, as it has northward, in the offshore direction. Therefore, while this single year of data analysis indicates that bowhead whales may make minor deflections in swimming direction at a distance of 30–35 km (18.6–21.7 mi), there is no indication that the SPL where deflection first begins is at 120 dB; it could be at another SPL lower or higher than 120 dB. Miller *et al.* (1999) also note that the received levels at 20–30 km (12.4–18.6 mi) were considerably lower in 1998 than have previously been shown to elicit avoidance in bowheads exposed to seismic pulses. However, the seismic airgun array used in 1998 was larger than the ones used in 1996 and 1997. Therefore, NMFS believes that it cannot scientifically support adopting any single SPL value below 160 dB and apply it across the board for all species and in all circumstances. Second, these minor course changes occurred during migration and, as indicated in MMS' 2006 PEA, have not been seen at other times of the year and during other activities. Third, as stated in the past, NMFS does not believe that minor course corrections during a migration equate to "take" under the MMPA. This conclusion is based on controlled exposure experiments conducted on migrating gray whales exposed to the U.S. Navy's low frequency sonar (LFA) sources (Tyack 2009). When the source was placed in the middle of the migratory corridor, the whales were observed deflecting around the source during their migration. However, such minor deflection is considered not to be biologically significant. To show the contextual nature of this minor behavioral modification, recent monitoring studies of Canadian seismic operations indicate that when, not migrating, but involved in feeding, bowhead whales do not move away from a noise source at an SPL of 160 dB. Therefore, while bowheads may avoid an area of 20 km (12.4 mi) around a noise source, when that determination requires a post-survey computer analysis to find that bowheads have made a 1 or 2 degree course change, NMFS believes that does not rise to a level of a "take." NMFS therefore continues to estimate "takings" under the MMPA from impulse noises, such as seismic, as being at a distance of 160 dB (re 1 µPa). Although it is possible that marine mammals could react to any sound levels detectable above the ambient noise level within the animals' respective frequency response range, this does not mean that such animals would react in a biologically significant way. According to experts on marine mammal behavior, the degree of reaction which constitutes a "take," *i.e.,* a reaction deemed to be biologically significant that could potentially disrupt the migration, breathing, nursing, breeding, feeding, or sheltering, etc., of a marine mammal is complex and context specific, and it depends on several variables in addition to the received level of the sound by the animals. These additional variables include, but are not limited to, other source characteristics (such as frequency range, duty cycle, continuous vs. impulse vs. intermittent sounds, duration, moving vs. stationary sources, etc.); specific species, populations, and/or stocks; prior experience of the animals (naive vs. previously exposed); habituation or sensitization of the sound by the animals; and behavior context (whether the animal perceives the sound as predatory or simply annoyance), etc. (Southall *et al.* 2007).

The references cited in the comment letters address different source characteristics (continuous sound rather than impulse sound that are planned for the proposed shallow hazard and site clearance surveys) or species (killer whales and harbor proposes) that rarely occur in the proposed Arctic action area. Some information about the responses of bowhead and gray whales to seismic survey noises has been acquired through dedicated research and marine mammal monitoring studies conducted during prior seismic surveys. Detailed descriptions regarding behavioral responses of these marine mammals to seismic sounds are available (*e.g.,* Richardson *et al.* 1995; review by Southall *et al.* 2007), and are also discussed in this document. Additionally, as Shell does not intend to use ice-breakers during its operations, statements regarding beluga reactions to icebreaker noise are not relevant to this activity.

Regarding the last point raised in this comment by AEWC, NMFS recognizes the concern. However, NMFS does not agree with AEWC's statement that current scientific research establishes that 120 dB (rms) is a more appropriate measure for impacts to marine mammals for reasons noted above. Based on the information and data summarized in Southall *et al.* (2007), and on information from various studies, NMFS believes that the onset for behavioral harassment is largely context dependent, and there are many studies showing marine mammals do not show behavioral responses when exposed to multiple pulses at received levels above 160 dB re 1 µPa (*e.g.,* Malme *et al.* 1983; Malme *et al.* 1984; Richardson *et al.* 1986; Akamatsu *et al.* 1993; Madsen and Møhl 2000; Harris *et al.* 2001; Miller *et al.* 2005). Therefore, although using a uniform SPL of 160–dB for the onset of behavioral harassment for impulse noises may not capture all of the nuances of different marine mammal reactions to sound, it is an appropriately conservative way to manage and regulate anthropogenic noise impacts on marine mammals. Therefore, unless and until an improved approach is developed and peer-reviewed, NMFS will continue to use the 160–dB threshold for determining the level of take of marine mammals by Level B harassment for impulse noise (such as from airguns).

Comment 10: NSB and AWL note that this IHA, as currently proposed, is based on uncertainties that are not allowed under the MMPA. Citing comments made by NMFS on recent MMS Lease Sale Environmental Impact Statements, NSB notes that NMFS stated that without more current and thorough data on the marine mammals in the Chukchi Sea and their use of these waters, it would be difficult to make the findings required by the MMPA. NSB notes that NMFS noted that the "continued lack of basic audiometric data for key marine mammal species" that occur throughout the Chukchi Sea inhibits the "ability to determine the nature and biological significance of exposure to various levels of both continuous and impulsive oil and gas activity sounds."

Response: NMFS agrees that while there may be some uncertainty on the current status of some marine mammal species in the Chukchi Sea and on impacts to marine mammals from seismic surveys, the best available information supports our findings. NMFS is currently proposing to conduct new population assessments for Arctic pinniped species, and current information is available on-line through the Stock Assessment Reports (SARs). Moreover, NMFS has required the industry to implement a monitoring and reporting program to collect additional information concerning effects to marine mammals.

In regard to impacts, there is no indication that seismic survey activities are having a long-term impact on marine mammals. For example, apparently, bowhead whales continued to increase in abundance during periods of intense seismic activity in the Chukchi Sea in the 1980s (Raftery *et al.* 1995; Angliss and Outlaw 2007), even without implementation of current mitigation requirements. As a result, NMFS believes that seismic survey noise in the Arctic will affect only small numbers of and have no more than a negligible impact on marine mammals in the Chukchi Sea. As explained in this document and based on the best available information, NMFS has determined that Shell's activities will affect only small numbers of marine mammals, will have a negligible impact on affected species or stocks, and will not have an unmitigable adverse impact on subsistence uses of the affected species or stocks.

Comment 11: AEWC notes that stranded marine mammals or their carcasses are also a sign of injury. NMFS states in its notice that it "does not expect any marine mammal will * * * strand as a result of the proposed survey" (75 FR 27708; May 18, 2010). In reaching this conclusion, NMFS claims that strandings have not been recorded for the Beaufort and Chukchi Seas. AEWC states that the Department of Wildlife Management of NSB has completed a study documenting 25 years worth of stranding data and showing that five dead whales were reported in 2008 alone in comparison with the five dead whales that were reported in the same area over the course of 25 years (Rosa 2009).

In light of the increase in seismic operations in the Arctic since 2006, AEWC says that NSB's study raises serious concerns about the impacts of these operations and their potential to injure marine mammals. AEWC states that while they think this study taken together with the June 2008 stranding of "melon headed whales off Madagascar that appears to be associated with seismic surveys" (75 FR 27708; May 18, 2010) demonstrate that seismic operations have the potential to injure marine mammals beyond beaked whales (and that Shell needs to apply for an LOA for its operations), certainly NSB's study shows that direct injury of whales is on-going. AEWC states that these direct impacts must be analyzed and explanations sought out before additional activities with the potential to injure marine mammals are authorized, and that NMFS must explain how, in light of this new information, Shell's application does not have the potential to injure marine mammals.

Response: NMFS has reviewed the information provided by AEWC regarding marine mammal strandings in the Arctic. The Rosa (2009) paper cited by AEWC does not provide any evidence linking the cause of death for the bowhead carcasses reported in 2008 to seismic operations. Additionally, the increased reporting of carcasses in the Arctic since 2006 may also be a result of increased reporting effort and does not necessarily indicate that there were fewer strandings prior to 2008. Marine mammal observers (MMOs) aboard industry vessels in the Beaufort and Chukchi Seas have been required to report sightings of injured and dead marine mammals to NMFS as part of the IHA requirements only since 2006.

Regarding the June 2008 stranding of melon headed whales off Madagascar, information available to NMFS at this time indicates that the seismic airguns were not active around the time of the stranding. While the Rosa (2009) study does present information regarding the injury of whales in the Arctic, it does not link the cause of the injury to seismic survey operations. As NMFS has stated previously, the evidence linking marine mammal strandings and seismic surveys remains tenuous at best. Two papers, Taylor *et al.* (2004) and Engel *et al.* (2004) reference seismic signals as a possible cause for a marine mammal stranding.

Taylor *et al.* (2004) noted two beaked whale stranding incidents related to seismic surveys. The statement in Taylor *et al.* (2004) was that the seismic vessel was firing its airguns at 1300 hrs on September 24, 2004, and that between 1400 and 1600 hrs, local fishermen found live stranded beaked whales 22 km (12 nm) from the ship's location. A review of the vessel's trackline indicated that the closest approach of the seismic vessel and the beaked whales stranding location was 18 nm (33 km) at 1430 hrs. At 1300 hrs, the seismic vessel was located 25 nm (46 km) from the stranding location. What is unknown is the location of the beaked whales prior to the stranding in relation to the seismic vessel, but the close timing of events indicates that the distance was not less than 18 nm (33 km). No physical evidence for a link between the seismic survey and the stranding was obtained. In addition, Taylor *et al.* (2004) indicates that the same seismic vessel was operating 500 km (270 nm) from the site of the Galapagos Island stranding in 2000. Whether the 2004 seismic survey caused the beaked whales to strand is a matter of considerable debate (*see* Cox *et al.* 2006). However, these incidents do point to the need to look for such effects during future seismic surveys. To date, follow up observations on several scientific seismic survey cruises have not indicated any beaked whale stranding incidents.

Engel *et al.* (2004), in a paper presented to the IWC in 2004 (SC/56/E28), mentioned a possible link between oil and gas seismic activities and the stranding of 8 humpback whales (7 off the Bahia or Espirito Santo States and 1 off Rio de Janeiro, Brazil). Concerns about the relationship between this stranding event and seismic activity were raised by the International Association of Geophysical Contractors (IAGC). The IAGC (2004) argues that not enough evidence is presented in Engel *et al.* (2004) to assess whether or not the relatively high proportion of adult strandings in 2002 is anomalous. The IAGC contends that the data do not establish a clear record of what might be a "natural" adult stranding rate, nor is any attempt made to characterize other natural factors that may influence strandings. As stated previously, NMFS remains concerned that the Engel *et al.* (2004) article appears to compare stranding rates made by opportunistic sightings in the past with organized aerial surveys beginning in 2001. If so, then the data are suspect.

Finally, if bowhead and gray whales react to sounds at very low levels by making minor course corrections to avoid seismic noise, and mitigation measures require Shell to ramp-up the seismic array to avoid a startle effect, strandings such as those observed in the Bahamas in 2000 are highly unlikely to occur in the Arctic Ocean as a result of seismic activity. Therefore, NMFS does not expect any marine mammals will incur serious injury or mortality as a result of Shell's 2010 survey operations, so an LOA is not needed.

Lastly, Shell is required to report all sightings of dead and injured marine mammals to NMFS and to notify the Marine Mammal Health and Stranding Response Network. However, Shell is not permitted to conduct necropsies on dead marine mammals. Necropsies can only be performed by people authorized to do so under the Marine Mammal Health and Stranding Response Program MMPA permit. NMFS is currently considering different methods for marking carcasses to reduce the problem of double counting. However, a protocol has not yet been developed, so marking is not required in the IHA.

Comment 12: AEWC and NSB state that research is increasingly showing that marine mammals may remain within dangerous distances of seismic operations rather than leave a valued resource such as a feeding ground (*see* Richardson 2004). The International Whaling Commission (IWC) scientific committee has indicated that the lack of deflection by feeding whales in Camden Bay (during Shell seismic activities) likely shows that whales will tolerate and expose themselves to potentially harmful levels of sound when needing to perform a biologically vital activity, such as feeding (mating, giving birth, etc.). Thus, the noise from Shell's proposed operations could injure marine mammals if they are close enough to the source. NSB further states that NMFS has not adequately analyzed the potential for serious injury.

Response: If marine mammals, such as bowhead whales, remain near a seismic operation to perform a biologically vital activity, such as feeding, depending on the distance from the vessel and the size of the 160-dB radius, the animals may experience some Level B harassment. A detailed analysis on potential impacts of anthropogenic noise (including noise from seismic airguns and other active acoustic sources used in geophysical surveys) is provided in the proposed IHA (75 FR 27708; May 18, 2010) and in this document. Based on the analysis, NMFS believes that it is unlikely any animals exposed to noise from Shell's proposed marine surveys would be exposed to received levels that could cause TTS (a non-injurious Level B harassment). Therefore, it is even less likely that marine mammals would be exposed to levels of sound from Shell's activity that could cause PTS (a non-lethal Level A harassment).

In addition, depending on the distance of the animals from the vessel and the number of individual whales present, certain mitigation measures are required to be implemented. If an aggregation of 12 or more mysticete whales are detected within the 160-dB radius, then the airguns must be shutdown until the aggregation is no longer within that radius. Additionally, if any whales are sighted within the 180-dB radius or any pinnipeds are sighted within the 190-dB radius of the active airgun array, then either a power-down or shutdown must be implemented immediately. For the reasons stated throughout this document, NMFS has determined that Shell's operations will not injure, seriously injure, or kill marine mammals.

Comment 13: AEWC states that NMFS does little to assess whether Level A harassment is occurring as a result of the deflection of marine mammals as a result of Shell's proposed operations. Deflected marine mammals may suffer impacts due to masking of natural sounds including calling to others of their species, physiological damage from stress and other non-auditory effects, harm from pollution of their environment, tolerance, and hearing impacts (*see* Nieukirk *et al.* 2004). Not only do these operations disrupt the animals' behavioral patterns, but they also create the potential for injury by causing marine mammals to miss feeding opportunities, expend more energy, and stray from migratory routes when they are deflected. Dr. Bain also states that there are three main ways that minor behavioral changes, when experienced by numerous individuals for extended periods of time, can affect population growth: Increased energy expenditure, reduced food acquisition, and stress (Trites and Bain 2000).

Response: See the response to comment 9 regarding the potential for injury. The paper cited by AEWC (Nieukirk *et al.* 2004) tried to draw linkages between recordings of fin, humpback, and minke whales and airgun signals in the western North Atlantic; however, the authors note the difficulty in assessing impacts based on the data collected. The authors also state that the effects of airgun activity on baleen whales is unknown and then cite to Richardson *et al.* (1995) for some possible effects, which AEWC lists in their comment. There is no statement in the cited study, however, about the

linkage between deflection and these impacts. While deflection may cause animals to expend extra energy, there is no evidence that this deflection is causing a significant behavioral change that will adversely impact population growth. In fact, bowhead whales continued to increase in abundance during periods of intense seismic activity in the Chukchi Sea in the 1980s (Raftery *et al.* 1995; Angliss and Outlaw 2007). Therefore, NMFS does not believe that injury will occur as a result of Shell's activities. Additionally, Shell's total data acquisition activities would only ensonify 7.3 km^2 to received levels above 160 dB of the Beaufort Sea (0.0016% of the entire Beaufort Sea). Therefore, based on the smaller radii associated with Shell's site clearance and shallow hazards surveys than the larger 2D or 3D seismic programs and the extremely small area of the Beaufort Sea where Shell will utilize airguns, it is unlikely that marine mammals will need to expend extra energy to locate prey or to have reduced foraging opportunities.

Comment 14: Citing Erbe (2002), AEWC notes that any sound at some level can cause physiological damage to the ear and other organs and tissues. Placed in a context of an unknown baseline of sound levels in the Chukchi Sea, it is critically important that NMFS take a precautionary approach to permitting additional noise sources in this poorly studied and understood habitat. Thus, the best available science dictates that NMFS use a more cautious approach in addressing impacts to marine mammals from seismic operations.

Response: The statement from Erbe (2002) does not take into account mitigation measures required in the IHA to reduce impacts to marine mammals. As stated throughout this document, based on the fact that Shell will be using a small airgun array (total discharge volume of 40 in^3) and will implement mitigation measures (*i.e.,* ramp-up, power-down, shutdown, etc.), NMFS does not believe that there will be any injury or mortality of marine mammals as a result of Shell's operations.

Comment 15: AEWC states that in making its negligible impact determination, NMFS failed to consider several impacts: (1) Displacing marine mammals from feeding areas; (2) non-auditory, physiological effects, namely stress; (3) the possibility of vessel strikes needs to be considered in light of scientific evidence of harm from ship traffic to marine mammals; (4) impacts to marine mammal habitat, including pollution of the marine environment and the risk of oil spills, toxic, and nontoxic waste being discharged; (5) impacts to fish and other food sources upon which marine mammals rely; and (6) specific marine mammals that will be taken, including their age, sex, and reproductive condition. The first issue was also raised by Dr. Bain.

Response: NMFS does not agree that these impacts were not considered. First, the area that would be ensonified by Shell's proposed open water marine surveys represents a small fraction of the total habitat of marine mammals in the Beaufort and Chukchi Seas. In addition, as the survey vessel is constantly moving, the ensonified zone where the received levels exceed 160 dB re 1 µPa (rms), which is estimated to be approximately 7.3 km^2 at any given time, is constantly moving. Therefore, the duration during which marine mammals would potentially avoid the ensonified area would be brief. Therefore, NMFS does not believe marine mammals would be displaced from their customary feeding areas as a result of Shell's proposed marine surveys.

Second, non-auditory, physiological effects, including stress, were analyzed in the Notice of Proposed IHA (75 FR 27708; May 18, 2010). No single marine mammal is expected to be exposed to high levels of sound for extended periods based on the size of the airgun array to be used by Shell and the fact that an animal would need to swim close to, parallel to, and at the same speed as the vessel to incur several high intensity pulses. This also does not take into account the mitigation measures described later in this document.

Third, impacts resulting from vessel strikes and habitat pollution and impacts to fish were fully analyzed in NMFS' 2010 Final EA for Shell and Statoil's open water marine and seismic activities (NMFS 2010). Additionally, the proposed IHA analyzed potential impacts to marine mammal habitat, including prey resources. That analysis noted that while mortality has been observed for certain fish species found in extremely close proximity to the airguns, Sætre and Ona (1996) concluded that mortality rates caused by exposure to sounds are so low compared to natural mortality that issues relating to stock recruitment should be regarded as insignificant.

For the sixth point, please *see* the response to comment 4. The age, sex, and reproductive condition must be provided when possible. However, this is often extremely difficult to predict. Additional mitigation measures for bowhead cow/calf pairs, such as monitoring the 120-dB radius and requiring shutdown when 4 or more cow/calf pairs enter that zone, were considered and required for this survey.

Comment 16: AEWC states that in assessing the level of take and whether it is negligible, NMFS relied on flawed density estimates that call into question all of NMFS' preliminary conclusions. AEWC states that density data are lacking or outdated for almost all marine mammals that may be affected by Shell's operations in the Beaufort and Chukchi Seas, especially for the fall. AEWC provided a few species specific examples to show that NMFS failed to utilize the best available scientific studies in assessing Shell's application. AEWC argues that NMFS' guess at the number of beluga and bowhead whales relies on a study from Moore *et al.* that was published in 2000, that the density of bowhead whales was derived from limited aerial surveys conducted by industry operators, and that these estimates are contrary to the best available scientific information. AEWC also points out that NMFS makes no mention of the most recent Alaska Marine Mammal Stock Assessment Report (SAR) which was released this year, and that the Assessment cites to a 2003 study that documented bowheads "in the Chukchi and Bering Seas in the summer" that are "thought to be a part of the expanding Western Arctic stock" (Angliss and Allen 2009). While a study published in 2003 still is not a sufficient basis for a 2009 density analysis, this study does show that additional information is available that indicates that the number of bowhead whales in the Chukchi may be higher than estimated by NMFS.

Response: As required by the MMPA implementing regulations at 50 CFR 216.102(a), NMFS has used the best scientific information available in assessing the level of take and whether it is negligible. Although most of the data NMFS depends on were collected over 10 years (1982–1991) from aerial surveys offshore of northern Alaska (Moore *et al.* 2000), these are the best scientific information available for bowhead and beluga whale density and distribution so far. Since approximately 10 days of Shell's proposed shallow hazards and site clearance surveys are likely to occur during the fall period when bowheads are migrating through the Beaufort Sea, more conservative estimates were made to take account for this 10-day moving average presented by Richardson and Thomson (2002). Additionally, the 2003 study noted by AEWC in the bowhead whale Alaska Marine Mammal SAR discusses distribution, not density (Rugh *et al.* 2003). It was not cited because it is not useful for deriving density estimates.

Therefore, density estimates for bowhead and beluga whales using Moore *et al.* (2000) are based on the best available science.

Comment 17: AEWC states that NMFS fails to explain how and why it reaches various conclusions in calculating marine mammal densities and what the densities are actually estimated to be once calculated. One example is NMFS' reliance on Moore *et al.* (2000) in making its density determinations. This study documented sightings of marine mammals but did not estimate the total number of animals present. AEWC states that NMFS's practices have resulted in entirely arbitrary calculations of the level of take of marine mammals and whether such takes constitute "small numbers" or a "negligible impact" as a result of Shell's proposal.

Response: All densities used in calculating estimated take of marine mammals based on the described operations are shown in Tables 6–1 to 6–3 of Shell's application. Moore *et al.* (2000) provides line transect effort and sightings from aerial surveys for cetaceans in the Chukchi Sea. The kilometers of "on-transect" observer effort and number of sightings were used in the accepted line-transect density estimate equation described in Buckland *et al.* (2001). Species specific correction factors for animals that were not at the surface or that were at the surface but were not sighted [g(0)] and animals not sighted due to distance from the survey trackline [f(0)] used in the equation were taken from reports or publications on the same species or similar species if no values were available for a given species, that used the same survey platform. Additional explanations regarding the calculations of marine mammal densities are provided in the Shell's application and the **Federal Register** notice for the proposed IHA (75 FR 27708; May 18, 2010). Therefore, NMFS believes the methodology used in calculations of the level of take of marine mammals is scientifically well supported.

Comment 18: AEWC is opposed to NMFS using "survey data" gathered by industry while engaging in oil and gas related activities and efforts to document their take of marine mammals. AEWC points out that such industry "monitoring" is designed to document the level of take occurring from the operation (*see* 75 FR 27724 and Shell's 4MP). AEWC argues that putting aside whether the methodologies employed are adequate for this purpose, they certainly are not adequate for assessing the density or presence of marine mammals that typically avoid such operations.

Response: In making its determinations, NMFS uses the best scientific information available, as required by the MMPA implementing regulations. For some species, density estimates from sightings surveys, as well as from "industry surveys", were provided in the text of Shell's application and the Notice of Proposed IHA for purposes of comparison. However, where information was available from sightings surveys (*e.g.,* Moore *et al.* 2000; Bengtson *et al.* 2005), those estimates were used to calculate take. Data collected on industry vessels were only used when no other information was available. Additionally, while some Arctic marine mammal species have shown fleeing responses to seismic airguns, data is also collected on these vessels during periods when no active seismic data collection is occurring.

Comment 19: AEWC states that as a general matter, when it comes to NMFS assessing the various stocks of marine mammals under the MMPA, it cannot use outdated data *i.e.,* "abundance estimates older than 8 years" because of the "decline in confidence in the reliability of an aged abundance estimate" (Angliss and Allen 2009) and the agency is thus unable to reach certain conclusions. Similarly, here, where data are outdated or nonexistent, NMFS should decide it cannot reach the necessary determinations. AEWC argues that these flaws in NMFS' analysis render the agency's preliminary determinations about the level of harassment and negligible impacts completely arbitrary.

Response: The statements quoted by AEWC from Angliss and Allen (2009) are contained in species SARs where abundance estimates are older than 8 years. However, the full statement reads as follows: "However, the 2005 revisions to the SAR guidelines (NMFS 2005) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate." Shell's activities are not anticipated to remove any individuals from the stock or population. Therefore, a recent estimate of PBR is not needed for NMFS to make the necessary findings under Section 101(a)(5)(D) of the MMPA. Additionally, Shell's application provides information (including data limitations) and references for its estimates of marine mammal abundance. Because AEWC has not provided information contrary to the data provided by Shell, and NMFS does not have information that these estimates are not reliable, NMFS considers these data to be the best available.

Comment 20: AWL argues that the effects of ice gouge and strudel scour surveying should be considered. AWL states that NMFS' dismissal of potential effects based on marine mammal hearing is not adequately supported. AWL and Dr. Bain argue that NMFS' approach fails to take into consideration the fact that: (1) Juvenile whales, based on their smaller size, likely hear sounds of higher frequencies than adults of the same species; (2) that sound sources contain frequencies beyond the "normal" frequency in the form of undertones, overtones, distortion, or noise; (3) NMFS failed to consider the beat frequency, that when a source simultaneously emits sound of more than one frequency, it will also emit energy at the difference between the two frequencies; (4) NMFS fails to take into account the fact that information about hearing abilities of bowhead whales is based on estimates since bowheads have not been the subject of direct testing and there is inherent uncertainty in these estimates; and (5) the **Federal Register** notice does not address the fact that toothed whales are sensitive to high-frequency sounds including those over 100 kHz.

Response: NMFS considered the potential effects of Shell's proposed ice gouge and strudel scour surveys in the Beaufort and Chukchi Seas (75 FR 27708; May 18, 2010). The reason NMFS does not think take of marine mammal is likely from ice gouge and strudel scour is because the active acoustic devices being used in these surveys are either in the frequency range above 180 kHz, which is beyond marine mammals functional hearing range, or with low source levels. In addition, due to their high-frequency nature, there is much absorption during sound propagation, which weakens much of the acoustic intensity within a relatively short range.

Although NMFS recognizes much scientific information is still needed on marine mammal hearing capability and audiograms, studies over the past sixty years on key common species across several major taxonomy groups have provided overall hearing ranges of marine mammal species (*see* review in Richardson *et al.* 1995; Southall *et al.* 2007). These studies show that marine mammal hearing ranges follow certain patterns and can be divided into five functional hearing groups: low-frequency cetacean (baleen whales), mid-frequency cetacean (mostly large to mid-size toothed whales, and delphinids), high-frequency cetacean (porpoises and river dolphins),

pinniped in water, and pinniped in air (Southall *et al.* 2007). Although it is possible that juvenile animals could have better hearing at high-frequency ranges similar to humans, however, the overall sensitivity that defines hearing is based on species (or hearing groups) instead of age groups. Therefore, it is incorrect to assume that juvenile whales hear sounds of higher frequencies because of their small size, regardless of species and functional hearing groups. In addition, the reason that juvenile animals (including humans) have slightly better high-frequency hearing is related to age rather than size (the principle behind it is a biological phenomenon called presbycusis, or aging ear).

Regarding point (2) concerning "normal" frequency, which was not defined in the comment, NMFS assumes that Dr. Bain refers to the frequenc(ies) outside the manufacturers' specs for their acoustic devices. Although these outlier noises could be a concern for high-frequency acoustic sources, especially if the frequencies are within the sensitive hearing range of marine mammals, NMFS does not believe these noises have high acoustic intensities in most cases. Nevertheless, NMFS requested that Shell provide frequency spectra and source characteristics for all of its acoustic devices. Shell reported back that it was unable to obtain such specifications from manufacturers. However, Shell will be required to conduct measurements of power density spectra (frequency spectra) of its high frequency active acoustic sources (operating frequency >180 kHz) that will be used in its marine surveys against ambient background noise levels. The power density spectra of these high frequency active acoustic sources will be reported in 1/3-octave band and 1-Hz band from 10 Hz to 180 kHz. The purpose for this measurement is to determine whether there is any acoustic energy within marine mammal hearing ranges that would be generated from operating these high frequency acoustic sources.

If significant acoustic energy (broadband source level >160 dB re 1 μPa @ 1 m in frequency band below 180 kHz) from these high frequency active acoustic sources exists within marine mammal hearing ranges, Shell is required to implement mitigation measures (such as establishing disturbance zones). Therefore, NMFS believes it unlikely that a marine mammal would be taken by this activity.

In regard to point (3), in order to produce "beat frequency," not only do the two sources have to be very close to each other, they also have to be perfectly synchronized. In the case of Shell's high-frequency sonar, these two interfering frequencies will need to be produced by one device to use the non-linearity of water to purposefully generate the different frequency between two high frequencies. Even so, it is a very inefficient way to generate the beat frequency, with only a low percentage of the original intensity with very narrow beamwidth. Therefore, NMFS does not consider this to be an issue of concern.

NMFS is aware that no direct measurements of hearing exist for these animals, and theories regarding their sensory capabilities are consequently speculative (for a detailed assessment by species using the limited available information, *see* Erbe 2002). In these species, hearing sensitivity has been estimated from behavioral responses (or lack thereof) to sounds at various frequencies, vocalization frequencies they use most, body size, ambient noise levels at the frequencies they use most, and cochlear morphometry and anatomical modeling (Richardson *et al.* 1995; Wartzok and Ketten 1999; Houser *et al.* 2001; Erbe 2002; Clark and Ellison 2004; Ketten *et al.* 2007). Though detailed information is lacking on the species level, the combined information strongly suggests that mysticetes are likely most sensitive to sound from perhaps tens of Hz to ~10 kHz (Southall *et al.* 2007). Although hearing ranges for toothed whales (mid- and high-frequency cetaceans) fall between 100s Hz to over 100 kHz, their most sensitive frequency lie between 10 to 90 kHz, and sensitivity falls sharply above 100 kHz.

Comment 21: Dr. Bain states that changes in behavior resulting from noise exposure could lead to indirect injury in marine mammals in the wild. He presented several examples to suggest that marine mammals repeatedly exposed to Level B harassment could result in Level A takes: (1) Harbor porpoise were observed traveling at high speeds during exposure to mid-frequency sonar in Haro Strait in 2003 and that exhaustion from rapid flight could lead to mortality; (2) citing MMS' (2004) Environmental Assessment on Proposed Oil and Gas Lease Sale 195 in the Beaufort Sea Planning Area (OCS EIS/EA MMS 2004–028) that feeding requires a prey density of 800 mg/m^3 and his own observation, Dr. Bain is concerned displacement from highly productive feeding areas would negatively affect individual whales and that small cetaceans such as harbor porpoise would face a risk of death if they are unable to feed for periods as short as 48–72 hours, or they may move into habitat where they face an increased risk of predation; and (3) individual killer whales have been observed splitting from their pod when frightened by sonar and that other killer whales' separation from their social units has resulted in death.

Response: NMFS agrees that it is possible that changes in behavior or auditory masking resulting from noise exposure could lead to injury in marine mammals under certain circumstances in the world, such as those examples/hypotheses raised by Dr. Bain. However, the assumption that Dr. Bain made that "exhaustion from rapid flight leading to heart or other muscle damage" could account for mortality merely because of exposure to airgun noise has no scientific basis. Also, it is not likely that received SPLs from the site clearance and shallow hazards surveys would cause drastic changes in behavior or auditory masking in marine mammals in the vicinity of the action area. First, marine mammals in the aforementioned examples and hypotheses were exposed to high levels of non-pulse intermittent sounds, such as military sonar, which has been shown to cause flight activities (*e.g.,* Haro Strait killer whales); and continuous sounds such as the vessel, which could cause auditory masking when animals are closer to the source. The sources produced by the acoustic equipment and airguns for Shell's site clearance and shallow hazards surveys are impulse sounds used in seismic profiling, bathymetry, and seafloor imaging. Unlike military sonar, seismic pulses have an extremely short duration (tens to hundreds of milliseconds) and relatively long intervals (several seconds) between pulses. Therefore, the sound energy levels from these acoustic sources and small airguns are far lower in a given time period. Second, the intervals between each short pulse would allow the animals to detect any biologically significant signals, and thus avoid or prevent auditory masking. Although airgun pulses at long distances (over kilometers) may be "stretched" in duration and become non-pulse due to multipath propagation, the intervals between the non-pulse noises would still allow biologically important signals to be detected by marine mammals. Especially due to the relatively small source being used for the site clearance and shallow hazard surveys, the received levels at such long distances would be even lower (*e.g.,* modeled received levels at 15 km are expected to be under 120 dB re 1 μPa). In addition, NMFS requires mitigation measures to ramp-up acoustic sources at a rate of no more than 6 dB per 5 min.

This ramp-up would prevent marine mammals from being exposed to high level noises without warning, thereby eliminating the possibility that animals would dramatically alter their behavior (*i.e.* from a "startle" reaction). NMFS also believes that long-term displacement of marine mammals from a feeding area is not likely because the seismic vessel is constantly moving, and the maximum 160-dB ensonified radius is about 1.22 km, which would create an area of ensonification of approximately 7.3 km^2 at any given moment, which constitutes a very small portion of the Beaufort Sea (0.0016 percent). In reality, NMFS expects the 160-dB ensonified zone to be smaller due to absorption and attenuation of acoustic energy in the water column.

Comment 22: Citing research on long term adverse effects to whales and dolphins from whale watching activities (Trites and Bain 2000; Bain 2002; Lusseau *et al.* 2009), Dr. Bain states that Level B behavioral harassment could be the primary threat to cetacean populations.

Response: Although NMFS agrees that long-term, persistent, and chronic exposure to Level B harassment could have a profound and significant impact on marine mammal populations, such as described in the references cited by Dr. Bain, those examples do not reflect the impacts of seismic surveys to marine mammals for Shell's project. First, whale watching vessels are intentionally targeting and making close approaches to cetacean species so the tourists onboard can have a better view of the animals. Some of these whale/dolphin watching examples cited by Dr. Bain occurred in the coastal waters of the Northwest Pacific between April and October and for extended periods of time ("[r]ecreational and scientific whale watchers were active by around 6 a.m., and some commercial whale watching continued until around sunset"). Thus multiple vessels have been documented to be in relatively close proximity to whales for about 12 hours a day, six months a year, not counting some "out of season" whale watching activities and after dark commercial filming efforts. In addition, noise exposures to whales and dolphins from whale watching vessels are probably significant due to the vessels' proximity to the animals. To the contrary, Shell's proposed open-water shallow hazard and site clearance surveys, along with existing industrial operations in the Arctic Ocean, do not intentionally approach marine mammals in the project areas. Shell's survey locations are situated in a much larger Arctic Ocean Basin, which is far away from most human impacts. Therefore, the effects from each activity are remote and spread farther apart, as analyzed in NMFS' 2010 EA, as well as the MMS 2006 PEA. Shell's site clearance and shallow hazards activities would only be conducted between July and October for 60 days, weather permitting. In addition, although studies and monitoring reports from previous seismic surveys have detected Level B harassment of marine mammals, such as avoidance of certain areas by bowhead and beluga whales during the airgun firing, no evidence suggests that such behavioral modification is biologically significant or non-negligible (Malme *et al.* 1986; 1988; Richardson *et al.* 1987; 1999; Miller *et al.* 1999; 2005), as compared to marine mammals exposed to chronic sound from whale watching vessels, as cited by Dr. Bain. Therefore, NMFS believes that potential impacts to marine mammals in the Chukchi Sea by site clearance and shallow hazards surveys would be limited to Level B harassment only, and due to the limited scale and remoteness of the project in relation to a large area, such adverse effects would not accumulate to the point where biologically significant effects would be realized.

Comment 23: Dr. Bain notes that NMFS uses different thresholds for continuous and pulsed sounds. Dr. Bain thus assumes that the motivation for this was to tie impact to SEL measurements of sound (as opposed to RMS or peak-to-peak measurements), which correlated well with TTS. Dr. Bain states that there is no evidence linking SEL to behavioral changes, and citing his paper (Bain and Williams, in review), Mr. Bain claims he found peak-to-peak level measurements correlated best with behavioral changes.

Response: First, Dr. Bain's assumption regarding NMFS' use of different behavioral thresholds for impulse and non-impulse noises are incorrect. The reason for the difference is not to tie impact to SEL measurements of sound to behavioral change, rather, this difference (received level at 160 dB re 1 µPa for pulse and 120 dB re 1 µPa for non-pulse) came from many field observations and analyses (*see* review by Richardson *et al.* 1995; Southall *et al.* 2007) on measured avoidance responses in whales in the wild. Specifically, the 160 dB re 1 µPa (rms) threshold was derived from data for mother-calf pairs of migrating gray whales (Malme *et al.* 1983; 1984) and bowhead whales (Richardson *et al.* 1985; Richardson *et al.* 1986) responding when exposed to seismic airguns (impulsive sound source). The 120 dB re 1µPa (rms) threshold also originates from research on baleen whales, specifically migrating gray whales (Malme *et al.* 1984; predicted 50% probability of avoidance) and bowhead whales reacting when exposed to industrial (*i.e.,* drilling and dredging) activities (non-impulsive sound source) (Richardson *et al.* 1990).

Dr. Bain's attached paper (Bain and Williams, in review) reports the results of an examination of effects of large airgun arrays on behavior of marine mammals in the waters of British Columbia, Canada and Washington State, USA, using a small boat to monitor out to long ranges (1 to > 70 km from the seismic source vessel). The paper concludes that a significant relationship was observed between the magnitude of behavioral response and peak-to-peak received level and the long distances at which behavioral responses were observed (> 60 km for harbor porpoise), along with counter-productive behavior that occasionally brought individuals into higher-intensity acoustic zones. However, there are potential design flaws in the study. First, the paper states a launch carried aboard the seismic receiver vessel was placed in the water to perform received level measurements near marine mammals. When making acoustic measurements, the launch "travelled along a line at approximately 20 km/h until either marine mammals were closely approached, or the launch had travelled 10 km." Therefore, it is highly likely that behavioral reactions from observed marine mammals were caused by the high-speed, close-approach of the launch, rather than from distant seismic airguns. This experiment design may explain the authors' observation of "counter-productive behavioral responses" that animals are moving into higher-intensity acoustic zones, which probably indicates that behavioral changes caused by Bain's launch greatly exceeded any behavioral change resulting from exposure to seismic airgun noise. Second, the authors of the paper also expressed "methodological concerns due to the subjectivity of observers." Nevertheless, this study concludes that harbor seal individuals were generally moving away from the airguns at exposure levels above 170 dB re 1 µPa (p–p) and that gray whales were observed at received levels up to approximately 170 dB re 1 µPa (p–p) exhibiting no obvious behavioral response. These observations contradict Mr. Bain's earlier comments that major behavioral effects result from noise in the 105–125 dB range.

Finally, Bain and Williams (in review) also state that the study "found that while airguns concentrated their sound output at low frequencies, substantial

high frequency energy (to at least 100 kHz) was also present." However, the paper provides no explanation as to how this conclusion was made. The accompanying power density spectrum (Figure 2 in Bain and Williams, in review) of the paper fails to show evidence that the frequencies above 1 kHz were mostly contributed from seismic airguns, and there was no indication at what distance this recording was made.

Subsistence Issues

Comment 24: AEWC states that the nondiscretionary congressional directive that there will be no more than a negligible impact to marine mammals and no unmitigable adverse impact to the availability of marine mammals for subsistence taking is consistent with the MMPA's overall treatment of both marine mammal and subsistence protections. AEWC further states that Congress has set a "moratorium on the taking * * * of marine mammals," 16 U.S.C. 1371(a), with the sole exemption provided for the central role of subsistence hunting by Alaska Natives. Thus, AEWC concludes that Congress has given priority to subsistence takes of marine mammals over all other exceptions to the moratorium, which may be applied for and obtained only if certain statutory and regulatory requirements are met. However, AEWC states that incidental harassment authorizations are available only for specified activities for which the Secretary makes the mandated findings. Thus, the pursuit of those activities is subordinated, by law, to the critical subsistence uses that sustain Alaska's coastal communities. NSB further states that NMFS has not adequately demonstrated that the proposed activities will not have "an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses."

Response: The MMPA does not prohibit an activity from having an adverse impact on the availability of marine mammals for subsistence uses; rather, the MMPA requires NMFS to ensure the activity does not have an unmitigable adverse impact on the availability of such species or stocks for taking for 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.

For the determination of the unmitigable adverse impact analysis, NMFS, other government agencies, and affected stakeholder agencies and communities were provided a copy of the draft POC in March 2010, which outlined measures Shell would implement to ensure no unmitigable adverse impact to subsistence uses. The POC specifies times and areas to avoid in order to minimize possible conflicts with traditional subsistence hunts by North Slope villages for transit and open-water activities. Shell waited to begin activities until the close of the spring beluga hunt in the village of Point Lay. Shell has also developed a Communication Plan and will implement the plan before initiating the 2010 program 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 Communication and Call Centers to be located in coastal villages along the Beaufort and Chukchi Seas during Shell's program in 2010.

Based on the measures contained in the IHA (and described later in this document), NMFS has determined that mitigation measures are in place to ensure that Shell's operations do not have an unmitigable adverse impact on the availability of marine mammal species or stocks for subsistence uses.

Mitigation and Monitoring Concerns

Comment 25: NSB is concerned that MMOs cannot *see* animals at the surface when it is dark or during the day because of fog, glare, rough seas, the small size of animals such as seals, and the large portion of time that animals spend submerged. NSB also notes that Shell has acknowledged that reported sightings are only "minimum" estimates of the number of animals potentially affected by surveying.

Response: NMFS recognizes the limitations of visual monitoring in darkness and other inclement weather conditions. Therefore, in the IHA to Shell, NMFS requires that no seismic airgun can be ramped up when the entire safety zones are not visible. However, Shell's operations will occur in an area where periods of darkness do not begin until early September. Beginning in early September, there will be approximately 1–3 hours of darkness each day, with periods of darkness increasing by about 30 min each day. By the end of the survey period, there will be approximately 8 hours of darkness each day. These conditions provide MMOs favorable monitoring conditions for most of the time.

Comment 26: AEWC notes that Shell intends to employ marine mammal observers ("MMO") and a "190 and 180 dB safety radii for pinnipeds and cetaceans, respectively, and the 160 dB disturbance radii" to mitigate these effects. However, AEWC states that the safety radii proposed by Shell do not negate these impacts. The safety radii only function as well as the observers on the vessels can *see* and report marine mammals within the radii or the general vicinity of the vessel. AEWC notes that MMOs are human and suffer from human flaws, and that observers are bad at judging distances in the water—*i.e.,* whether a marine mammal is within the radii or not. AEWC further states that at night and during storms MMOs are particularly ineffective. Thus, AEWC concludes that Shell's proposed MMO program is not sufficient mitigation to prevent Shell from engaging in Level A harassment.

Response: NMFS does not agree with AEWC's observation and conclusion, although AEWC is right that distance judging in the water is a challenging issue for MMOs. However, as noted in Shell's Marine Mammal Monitoring and Mitigation Plan (4MP), distances to nearby marine mammals will be estimated with binoculars (Fujinon 7 x 50) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. In addition, MMOs may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 600 m (1,968 ft)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels—while the isopleth to the 180 dB received level is expected to be at 125 m (410 ft) from the source vessel. Therefore, NMFS believes that marine mammal monitoring efforts that would be employed by Shell during its marine surveys are adequate.

In addition, mitigation measures such as ramp-up of airguns would warn any marine mammals that are missed during the pre-survey period to leave the survey vicinity. Lastly, recent studies show that it is unlikely a marine

mammal would experience TTS when exposed to a seismic pulse at a received level of 190 dB (*see* Finneran *et al.* 2002). In order for a marine mammal to experience even a mild TTS, the animal has to be in a zone with intense noise for a certain duration to and be exposed to a sound level much greater than a single seismic impulse, and research on marine mammal behavior during TTS experiments indicates that animals will try to avoid areas where receive levels are high enough to cause TTS (*see* Finneran *et al.* 2002).

Comment 27: NSB and AEWC note that Shell asserts that mitigation measures are designed to protect animals from injurious takes, but it is not clear that these mitigation measures are effective in protecting marine mammals or subsistence hunters. AEWC states that data previously presented by Shell and ConocoPhillips from their seismic activities made clear that MMOs failed to detect many marine mammals that encroached within the designated safety zones. AEWC further notes that Shell admits that night vision devices "are not nearly as effective as visual observation during daylight hours."

Response: NMFS believes that the required monitoring and mitigation measures are effective and are an adequate means of effecting the least practicable impact to marine mammals and their habitat. Moreover, the safety zones for Shell's 2010 surveys are much smaller than those for the larger 3D seismic surveys in past years. The 180- and 190-dB safety zones are 125 m (410 ft) and 35 m (115 ft), respectively. The monitoring reports from 2006, 2007, 2008, and 2009 do not note any instances of serious injury or mortality (Patterson *et al.* 2007; Funk *et al.* 2008; Ireland *et al.* 2009; Reiser *et al.* 2010). Additionally, the fact that a power-down or shutdown is required does not indicate that marine mammals are not being detected or that they are incurring serious injury. As discussed elsewhere in this document and in the Notice of Proposed IHA (75 FR 27708; May 18, 2010), the received level of a single seismic pulse (with no frequency weighting) might need to be approximately 186 dB re 1 μPa^2-s (*i.e.,* 186 dB sound exposure level [SEL]) in order to produce brief, mild TTS (a non-injurious, Level B harassment) in odontocetes. 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. For Shell's proposed survey activities, the distance at which the received energy level (per pulse) would be expected to be ≥175–180 dB SEL is the distance to the 190 dB re 1 μPa (rms) isopleth (given that the rms level is approximately 10–15 dB higher than the SEL value for the same pulse). Seismic pulses with received energy levels ≥175–180 dB SEL (190 dB re 1 μPa (rms)) are expected to be restricted to a radius of approximately 35 m (115 ft) around the airgun array.

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. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales.

In pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.* 1999; 2005). However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal, which is closely related to the ringed seal) may occur at a similar SEL as in odontocetes (Kastak *et al.* 2004).

NMFS 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. As summarized above, data that are now available imply that TTS is unlikely to occur unless bow-riding odontocetes are exposed to airgun pulses much stronger than 180 dB re 1 μPa rms (Southall *et al.* 2007). No cases of TTS are expected as a result of Shell's proposed activities given the small size of the source, the strong likelihood that baleen whales (especially migrating bowheads) would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS, and the mitigation measures proposed to be implemented during the survey described later in this document.

There is no empirical evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns (*see* Southall *et al.* 2007). PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal is exposed to the strong sound pulses with very rapid rise time.

It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during a project employing the airgun sources planned here (*i.e.,* an airgun array with a total discharge volume of 40 in^3). In the proposed project, marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause more than slight TTS. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. In fact, even the levels immediately adjacent to the airgun may not be sufficient to induce PTS, especially because a mammal would not be exposed to more than one strong pulse unless it swam immediately alongside the airgun for a period longer than the inter-pulse interval. Baleen whales, and belugas as well, generally avoid the immediate area around operating seismic vessels. The planned monitoring and mitigation measures, including visual monitoring, power-downs, and shutdowns of the airguns when mammals are seen within the safety radii, will minimize the already-minimal probability of exposure of marine mammals to sounds strong enough to induce PTS.

NMFS acknowledges that night-time monitoring by using night vision devices is not nearly as effective as visual observation during daylight hours. Therefore, the IHA to Shell prohibits start up of seismic airguns when the entire safety zone can not be effectively monitored during the night-time hours. If Shell has a shutdown of its seismic airgun array during low-light hours, it will have to wait till daylight to start ramping up the airguns.

Comment 28: The Commission believes that absent an evaluation by the oil and gas industry of its monitoring and mitigation measures, the effects of the industry's activities will remain uncertain. The Commission recommends that NMFS require Shell to collect information necessary to evaluate the effectiveness of the

mitigation measures adopted and to review and modify mitigation measures accordingly. The Commission notes that mitigation measures required for Shell's proposed marine surveys should be useful to a degree, but in some cases they are not sufficiently specific. For example, the Commission raised questions about the "power-down" and asks NMFS to specify what speed of reduction would be required when a marine mammal is observed within 274 m (300 yards) of a vessel. The Commission considers it vital that NMFS and the industry make every reasonable effort to evaluate the mitigation measures whenever possible, and that the evaluation should provide a basis for (1) Distinguishing between measures that do and do not have protective value, (2) improving those that are useful, and (3) finding alternatives for those that are not. Citing a report from the Joint Subcommittee on Ocean Science and Technology, NSB also questions the effectiveness of ramp-up measures.

Response: 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). For Shell's proposed open water marine surveys, a series of mitigation and monitoring measures are required under the IHA. These mitigation measures include: (1) Sound source measurements to determine safety zones more accurately, (2) establishment of safety and disturbance zones to be monitored by MMOs on the seismic vessel, (3) a power-down when a marine mammal is detected approaching a safety zone and a shutdown when a marine mammal is observed within a zone, (4) ramp-up of the airgun array, (5) establishing a 120-dB safety zone and prohibition of seismic surveys within that zone whenever it encompasses four or more bowhead whale mother-calf pairs, (6) establishing a 160-dB safety zone that would prohibit firing of the seismic airguns within the zone whenever it encompasses 12 or more bowhead or gray whales involved in non-migratory behavior (*e.g.,* feeding), and (7) a requirement that vessels reduce speed when within 274 m (300 yards) of whales and steer around those whales if possible.

The basic rational for these mitigation measures is (a) To avoid exposing marine mammals to intense seismic airgun noises at received levels that could cause TTS (for mitigation measures listed as (1) through (4)), (b) to avoid exposing large aggregations of bowhead whales and bowhead whale calves to elevated noise received levels (mitigation measures (5) and (6)), and (c) to avoid vessel strike of marine mammals (mitigation measure (7)). Although limited research in recent years shows that noise levels that could induce TTS in odontocetes and pinnipeds are much higher than current NMFS safety thresholds (*i.e.,* 180 dB and 190 dB re 1 μPa (rms) for cetaceans and pinnipeds, respectively), mitigation measures listed in (1) through (3) provide very conservative measures to ensure that no marine mammals are exposed to noise levels that would result in TTS. The power-down measure listed in (3) requires Shell to reduce the firing airguns accordingly so that a marine mammal that is detected approaching the safety zone will be further away from the reduced safety radius (as a result of power-down).

Regarding mitigation measures requiring ramp-ups, while scientific research built around the question on whether ramp-up is effective has not been conducted, several studies on the effects of anthropogenic noise on marine mammals indicate that many marine mammals will move away from a sound source that they find annoying (*e.g.* Malme *et al.* 1984; Miller *et al.* 1999; others reviewed in Richardson *et al.* 1995). In particular, three species of baleen whales have been the subject of tests involving exposure to sounds from a single airgun, which is equivalent to the first stage of ramp-up. All three species were shown to move away at the onset of a single airgun operation (Malme *et al.* 1983; 1984; 1985; 1986; Richardson *et al.* 1986; McCauley *et al.* 1998; 2000). From this research, it can be presumed that if a marine mammal finds a noise source annoying or disturbing, it will move away from the source prior to sustaining an injury, unless some other over-riding biological activity keeps the animal from vacating the area. This is the premise supporting NMFS' and others' belief that ramp-up is effective in preventing injury to marine mammals. However, to what degree ramp-up protects marine mammals from exposure to intense noises is unknown. Thus, NMFS will require industry applicants that will conduct marine or seismic surveys in the 2010 open water season to collect, record, analyze, and report MMO observations during any ramp-up period, as recommended by the independent peer review panel convened in March 2010, to review Shell's monitoring plan (more information is available later in this document).

Mitigation measures (5) and (6) regarding four cow-calf pairs and an aggregation of 12 bowhead and/or gray whales, which were proposed in MMS' 2006 programmatic EA and were required in NMFS IHAs issued between 2006 to 2008, need to be further analyzed for their effectiveness and efficacy. NMFS is currently conducting a review of these mitigation measures through the Environmental Impact Statement process for the Arctic oil and gas activities.

Finally, regarding the speed reduction for vessels in the vicinity of marine mammals, NMFS clarifies that vessel speed must be reduced to less than 10 knots when a marine mammal is detected within 274 m (300 yards) of the vessel. This mitigation measure is to avoid vessel strike of marine mammals and is based on NMFS' ship strike rule for the north Atlantic right whale. NMFS will evaluate the efficacy of this mitigation. Although there has never been a vessel strike of marine mammals by vessels involved in seismic activities in the Arctic, NMFS is still taking this precaution.

Comment 29: The Commission recommends that Shell be required to supplement its mitigation measures by using passive acoustic monitoring (PAM) to provide a more reliable estimate of the number of marine mammals taken during the course of the proposed seismic survey.

Response: NMFS' 2010 EA for this action contains an analysis of why PAM is not required to be used by Shell to implement mitigation measures. Shell will deploy acoustic recorders to collect data on vocalizing animals. However, this information will not be used in a real-time or near-real-time capacity. Along with the fact that marine mammals may not always vocalize while near the PAM device, another impediment is that flow noise generated by a towed PAM will interfere with low frequency whale calls and make their detection difficult and unreliable. MMS sponsored a workshop on the means of acoustic detection of marine mammals in November 2009 in Boston, MA. The workshop reviewed various available acoustic monitoring technology (passive and active), its feasibility and applicability for use in MMS-authorized activities, and what additional developments need to take place to

improve its effectiveness. The conclusion is that at this stage, using towed passive acoustics to detect marine mammals is not a mature technology. NMFS may consider requirements for PAM in the future depending on information received as the technology develops further. Additionally, NMFS recommended to Shell that the company work to help develop and improve this type of technology for use in the Arctic.

Comment 30: AWL states that NMFS should consider time and space limitations on surveying in order to reduce harm, and that there is a general consensus that spatial-temporal avoidance of high value habitat represents one of the best means to diminish potential impacts. In this case, AWL requests NMFS to evaluate the possibility of avoiding activities during the peak of the bowhead migration within the Beaufort migratory corridor before issuing an IHA. In addition, AWL requests NMFS to require Shell to complete its 30 days of shallow hazard surveying in July and August in an effort to avoid—as much as possible—the bulk of the bowhead migration.

Response: In making its negligible determination for the issuance of an IHA to Shell for open water marine surveys, NMFS has conducted a thorough review and analysis on how to reduce any adverse effects to marine mammals from the proposed action, including the consideration of time and space limitations that could reduce impacts to the bowhead migration. As Shell indicates in its IHA application, the majority of the site clearance and shallow hazards surveys will be conducted during August and September to avoid the peak of the bowhead whale migration through the Beaufort Sea, which typically occurs in mid-September and October.

In addition, bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive to airgun noises, with avoidance occurring out to distances of 20–30 km from a medium-sized airgun source (Miller *et al.* 1999; Richardson *et al.* 1999). However, while bowheads may avoid an area of 20 km (12.4 mi) around a noise source, when that determination requires a post-survey computer analysis to find that bowheads have made a 1 or 2 degree course change, NMFS believes that does not rise to a level of a "take" and that such minor behavioral modification is not likely to be biologically significant.

Comment 31: The Commission recommends that NMFS (1) Review the proposed monitoring measures to ensure that Shell is required to gather information on all the potentially important sources of noise and the complex sound field that the seismic survey activities create; (2) work with Shell and its contractors to engage acknowledged survey experts to review the survey design and planned analyses to ensure that Shell will provide relatively unbiased and reliable results; (3) work with Shell to coordinate a comparative analysis of the results of vessel-based, aerial, and passive acoustic monitoring methods to evaluate their relative strengths and weaknesses and determine if and how they could be improved for use with future surveys; (4) develop a plan for collecting meaningful baseline information—that is, information that provides a reliable basis for evaluating long-term effects on the marine mammal species and stocks that may be affected by oil and gas development and production in the Beaufort Sea area; and (5) work with Shell to determine how the data collected during the proposed activities can be made available to other scientific purposes.

Response: NMFS largely agrees with the Commission's recommendations and has been working with the seismic survey applicants and their contractors on gathering information on acoustic sources, survey design review, and monitoring analyses. NMFS has contacted Shell and received information on all the active acoustic sources that would be used for its proposed open water marine surveys. The information includes source characteristics such as frequency ranges and source levels, as well as estimated propagation loss. In addition, at NMFS' request, Shell has provided power density spectra for all of its high-frequency sonar equipments.

Regarding the remaining points, NMFS convened an independent peer review panel to review Shell's 4MP for the Open Water Marine Survey Program in the Beaufort and Chukchi Seas, Alaska. The panel met on March 25 and 26, 2010, and provided their final report to NMFS on April 22, 2010. NMFS has reviewed the report and evaluated all recommendations made by the panel. NMFS has determined that there are several measures that Shell can incorporate into its 2010 open water Marine Survey Program 4MP to improve it, and is requiring those measures in the IHA. Additionally, there are other recommendations that NMFS has determined would also result in better data collection, and could potentially be implemented by oil and gas industry applicants, but which likely could not be implemented for the 2010 open-water season due to technical issues (*see* below). A detailed discussion about the panel review is presented later in this document. While it may not be possible to implement those changes this year, NMFS believes that they are worthwhile and appropriate suggestions that may require a bit more time to implement, and Shell should consider incorporating them into future monitoring plans should Shell decide to apply for IHAs in the future. Nevertheless, despite these recommendations, NMFS believes that Shell's 4MP will be sufficient for purposes of data gathering in 2010.

Comment 32: The Commission recommends that the IHA require Shell to halt its seismic survey and consult with NMFS regarding any seriously injured or dead marine mammal when the injury or death may have resulted from Shell's activities.

Response: NMFS concurs with the Commission's recommendation. NMFS has included a condition in the IHA which requires Shell to immediately shutdown the seismic airguns if a dead or injured marine mammal has been sighted within an area where the seismic airguns were operating within the past 24 hours so that information regarding the animal can be collected and reported to NMFS. In addition, Shell must report the events to the Marine Mammal Stranding Network within 24 hours of the sighting, as well as to the NMFS staff person designated by the Director, Office of Protected Resources, or to the staff person designated by the Alaska Regional Administrator. The lead MMO is required to complete a written certification, which must include the following information: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). In the event that the marine mammal injury or death was determined to have been a direct result of Shell's activities, then operations will cease, NMFS and the Stranding Network will be notified immediately, and operations will not be permitted to resume until NMFS has had an opportunity to review the written certification and any accompanying documentation, make determinations as to whether modifications to the activities are appropriate and necessary, and has notified Shell that activities may be resumed.

If NMFS determines that further investigation is appropriate, once investigations are completed and determinations made, NMFS would use available information to help reduce the

likelihood that a similar event would happen in the future and move forward with necessary steps to ensure environmental compliance for oil and gas related activities under the MMPA.

Cumulative Impact Concerns

Comment 33: NSB, AEWC, ICAS, and AWL state that NMFS must also consider the effects of disturbances in the context of other activities occurring in the Arctic. NSB states that NMFS should ascertain the significance of multiple exposures to underwater noise, ocean discharge, air pollution, and vessel traffic—all of which could impact bowhead whales and decrease survival rates or reproductive success. NSB notes that the cumulative impacts of all industrial activities must be factored into any negligible impact determination. NSB, AEWC, ICAS, and AWL list a series of reasonably foreseeable activities in the Arctic Ocean as: (1) GX Technology's Beaufort Sea seismic surveys; (2) Statoil's Chukchi Sea seismic surveys; (3) Seismic surveys planned in the Canadian Arctic; (4) U.S. Geological Survey's (USGS') seismic surveys; (5) BP's production operations at Northstar; and (6) Dalmorneftegeophysica (DMNG) Russian Far East offshore seismic surveys.

Response: Under section 101(a)(5)(D) of the MMPA, NMFS is required to determine whether the taking by the applicant's specified activity will take only small numbers of marine mammals, will have a negligible impact on the affected marine mammal species or population stocks, and will not have an unmitigable impact on the availability of affected species or stocks for subsistence uses. Cumulative impact assessments are NMFS' responsibility under the National Environmental Policy Act (NEPA), not the MMPA. In that regard, MMS' 2006 Final PEA, NMFS' 2007 and 2008 Supplemental EAs, NMFS' 2009 EA, and NMFS' 2010 EA address cumulative impacts. The most recent NMFS' 2010 EA addresses cumulative activities and the cumulative impact analysis focused on oil and gas related and non-oil and gas related activities in both Federal and State of Alaska waters that were likely and foreseeable. The oil and gas related activities in the U.S. Arctic in 2010 include this activity; Statoil's proposed seismic survey in Chukchi Sea; ION Geophysical's proposed seismic survey in Beaufort Sea; and BP's production operations at Northstar. GX Technology's Beaufort Sea seismic surveys have been cancelled by the company. Seismic survey activities in the Canadian and Russian Arctic occur in different geophysical areas, therefore, they are not analyzed under the NMFS 2010 EA. Other appropriate factors, such as Arctic warming, military activities, and noise contributions from community and commercial activities were also considered in NMFS' 2010 EA. Please refer to that document for further discussion of cumulative impacts.

Comment 34: Citing the peer review panel created for this year's open water meeting that Shell's activities "will create a complex sound field with potential effects beyond those that the applicant proposes to monitor," and NRC's advice on assessing cumulative effects to the population from multiple effects to multiple individuals, the AWL recommends NMFS create a sound budget for the Arctic, limiting the total amount of sound introduced into the water. The AWL further states that instead of dismissing the impacts of relatively smaller sources of sound, NMFS should account for and regulate those sources, and a sound budget may be the most appropriate tool for doing so. The AWL states that even without a comprehensive sound budget, NMFS could impose limits on the total number of activities permitted in the Arctic during the open water season. Allowing only one or two noise generating activities each year could reduce the potential for take and would facilitate additional monitoring of the impacts of noise, since multiple noise sources make it very difficult to study the effect of specific sound sources.

Response: NMFS agrees that assessing cumulative effects to the population from multiple effects to multiple individual marine mammals is an important approach to understanding overall impacts of industry activities to the species and the environment. NMFS is also considering the peer review panel's recommendation and is addressing sound budget issues in the marine environment through a series of workshops and a working group. In addition, Shell is required to provide sound source verification (SSV) tests before they start marine surveys. These acoustic measurements will be analyzed and provided in the 90-day report for Shell's marine surveys. Additional information on Arctic sound budget data are being collected by many researchers, including underwater recordings made by some of the passive acoustic arrays deployed on the Alaska north slope. These data will hopefully be analyzed to address overall ambient sound levels and a sound budget for the Arctic Ocean.

Further, NMFS also requested that Shell provide source characteristics for all active acoustic sources that are planned to be used in the proposed open water marine surveys. NMFS has reviewed these data and analyzed overall ambient sound levels in the Arctic Ocean based on current knowledge. The review and analysis showed that the short-term ensonification of a small region in the Beaufort and Chukchi Seas during the open water season is not likely to appreciably increase the ambient noise level and alter the local ocean soundscape. A description of the analysis is provided in NMFS' 2010 EA for Shell and Statoil's proposed open water marine and seismic surveys (NMFS 2010).

Finally, as NMFS is working on its Arctic EIS, limits on the total of oil and gas related activities to be allowed in the Arctic are being considered under separate alternatives. Nevertheless, NMFS does not agree with AWL's notion of "[a]llowing only one or two noise generating activities each year" as monitoring reports and studies from prior year industrial activities (*e.g.,* there were five seismic survey activities in the open water season of 2008) indicate that multiple activities can be authorized in the Arctic while still reaching a finding of no significant impact, provided that appropriate mitigation and monitoring measures are prescribed and implemented.

Comment 35: In addressing cumulative effects, Dr. Bain points out a number of ways he believes that Statoil's seismic surveys in the Chukchi Sea could interact with Shell's marine surveys: (1) If the same individuals are exposed to both projects, this would increase the duration of exposure beyond those considered in the applications. Further, individuals would potentially be exposed multiple times, and multiple exposures are likely to result in increased stress levels; (2) if both projects operate in the Chukchi at the same time, individuals would be forced to simultaneously respond to both noise sources. Avoidance of one noise source could result in a marine mammal approaching the other noise source, resulting in unexpectedly high noise exposure. This negates the safety assumption that animals will move away prior to receiving harmful exposure; and (3) different individuals may be exposed to the two projects, which would put NMFS' assumption that its policies only allow small takes to occur into question.

Response: In assessing the cumulative effects, NMFS has considered that animals could be exposed to multiple activities, multiple times. As described in detail in the proposed IHA (75 FR

27708; May 18, 2010), Shell's ice gouge survey in the Chukchi Sea is not expected to result in takes of marine mammals due to its high frequency and the low energy acoustic sources being used. In addition, even if marine mammals would be affected by the presence of the ice gouge survey activities being conducted concurrently with Statoil's 3D marine seismic survey, the affected areas represent a small fraction of the total habitat of the Chukchi Sea, therefore, it is not likely that marine mammals avoiding one source would run into the other, as suggested by Dr. Bain. The ensonified area with received levels above 160 dB in the Chukchi Sea is 531 km^2 (or 0.089 percent of the entire Chukchi Sea). Finally, considering different individuals may be exposed to two projects in both the Beaufort and Chukchi Seas, NMFS has provided the total number of individuals that could be taken by Level B harassment from both activities and concludes that the total take numbers are small, with the most potential takes being: 184 Eastern Chukchi Sea beluga whales (4.95% of the population), 539 B–C–B bowhead whales (3.78% population), and 6,629 Alaska ringed seals (2.87% population). Potential takes of all other species are estimated to be under 1% of the populations. Therefore, NMFS believes Dr. Bain's concerns are not warranted.

ESA Concerns

Comment 36: AWL states that NMFS section 7 consultation under the ESA must consider the potential impact of potential future oil and gas activities, including (1) Shell's strudel scour and ice gouge surveying to enable pipeline construction for production on its proposed Chukchi and Beaufort drill sites; and (2) a shallow hazard survey in Harrison Bay to allow for later exploration drilling. AWL states that in both instances, NMFS must consider the effects of the entire agency action.

Response: Under section 7 of the ESA, NMFS Office of Protected Resources has completed consultation with NMFS Alaska Regional Office on "Authorization of Small Takes under the Marine Mammal Protection Act for Certain Oil and Gas Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska for 2010." In a Biological Opinion issued on July 13, 2010, NMFS concluded that the issuance of the incidental take authorizations under the MMPA for seismic surveys are not likely to jeopardize the continued existence of the endangered humpback or bowhead whale. As no critical habitat has been designated for these species, none will be affected. The 2010 Biological Opinion takes into consideration all oil and gas related seismic survey activities that would occur in the 2010 open water season. This Biological Opinion does not include impacts from exploratory drilling and production activities, which are subject to a separate consultation. In addition, potential future impacts from oil and gas activities will be subject to consultation in the future when activities are proposed. NMFS has reviewed Shell's proposed action and has determined that the findings in the 2010 Biological Opinion apply to its 2010 Beaufort Sea site clearance and shallow hazards surveys. In addition, NMFS has issued an Incidental Take Statement (ITS) under this Biological Opinion for Shell's survey activities, which contains reasonable and prudent measures with implementing terms and conditions to minimize the effects of take of bowhead and humpback whales.

Comment 37: AWL argues that NMFS' existing regional biological opinion is inadequate. AWL states that NMFS' 2008 Biological Opinion does not adequately consider site-specific information related to Shell's proposed drilling. AWL points out that Shell has proposed exploration drilling in Camden Bay in the Beaufort Sea, and that Camden Bay has been repeatedly identified as a resting and feeding area for migrating bowheads, which has been reaffirmed by the recent monitoring. AWL states that NMFS should re-examine the potential impacts of Shell's proposed drilling in light of its long-standing policy and the cautionary language contained in its 2008 opinion.

Response: NMFS initiated a section 7 consultation under the ESA for the potential impacts to ESA-listed marine mammal species that could be adversely affected as a result of several oil and gas related activities in the 2010 open-water season. The 2010 Biological Opinion covered the activities by Shell, Statoil, and ION's proposed open water marine and seismic survey activities. However, as far as Shell's drilling activities are concerned, Shell has withdrawn these actions due to the moratorium on offshore drilling.

Comment 38: AWL argues that NMFS' 2008 Biological Opinion does not adequately consider oil spills. AWL states that in the 2008 Biological Opinion, NMFS recognized the potential dangers of a large oil spill, and that whales contacting oil, particularly freshly-spilled oil, "could be harmed and possibly killed." Citing NMFS's finding in its 2008 Biological Opinion that several "coincidental events" would have to take place for such harm to occur: (1) A spill; (2) that coincides with the whales' seasonal presence; (3) that is "transported to the area the whales occupy (*e.g.,* the migrational corridor or spring lead system)"; and (4) is not successfully cleaned up. AWL points out that this combination of events is not as remote as NMFS appears to have assumed because NMFS' analysis of whether a spill may occur relies in part on statistical probabilities based on past incidents. AWL states that there appears to have been a significant breakdown in the system that was intended to both prevent spills from occurring and require adequate oil spill response capabilities to limit the harm. AWL states that NMFS must take into account that there are likely gaps in the current regulatory regime, and that given those flaws, an analysis that relies on the safety record of previous drilling is doubtful as a predictive tool.

Response: As discussed in the previous Response to Comment, no drilling is planned for Shell during the 2010 open water season, therefore, these activities will be considered in a separate consultation if and when Shell proposes to conduct exploratory drilling because seismic activities do not raise an oil-spill concern.

NEPA Concerns

Comment 39: AEWC believes that NMFS, in direct contravention of the law, excluded the public from the NEPA process since NMFS did not release a draft EA for the public to review and provide comments prior to NMFS taking its final action.

Response: Neither NEPA nor the Council on Environmental Quality's (CEQ) regulations explicitly require circulation of a draft EA for public comment prior to finalizing the EA. The Federal courts have upheld this conclusion, and in one recent case, the Ninth Circuit squarely addressed the question of public involvement in the development of an EA. In *Bering Strait Citizens for Responsible Resource Development* v. *U.S. Army Corps of Engineers* (524 F.3d 938, 9th Cir. 2008), the court held that the circulation of a draft EA is not required in every case; rather, Federal agencies should strive to involve the public in the decision-making process by providing as much environmental information as is practicable prior to completion of the EA so that the public has a sufficient opportunity to weigh in on issues pertinent to the agency's decision-making process. In the case of Shell's 2010 MMPA IHA request, NMFS involved the public in the decision-making process by distributing Shell's IHA application and addenda for a 30-

day notice and comment period. However, at that time, a draft EA was not available to provide to the public for comment. The IHA application and NMFS' Notice of Proposed IHA (75 FR 27708; May 18, 2010) contained information relating to the project. For example, the application included a project description, its location, environmental matters such as species and habitat to be affected, and measures designed to minimize adverse impacts to the environment and the availability of affected species or stocks for subsistence uses.

Comment 40: AEWC notes that Shell's IHA application warrants review in an environmental impact statement (EIS) given the potential for significant impacts.

Response: NMFS' 2010 EA was prepared to evaluate whether significant environmental impacts may result from the issuance of an IHA to Shell, which is an appropriate application of NEPA. After completing the EA, NMFS determined that there would not be significant impacts to the human environment and accordingly issued a FONSI. Therefore, an EIS is not needed for this action.

Comment 41: AEWC, AWL, and NSB note that NMFS is preparing a Programmatic EIS (PEIS). Although MMS published a draft PEIS (PEIS; MMS 2007) in the summer of 2007, to date, a Final PEIS has not been completed. AWL also notes that NMFS and MMS have reaffirmed their previous determination that a programmatic EIS process is necessary to address the overall, cumulative impacts of increased oil and gas activity in the Arctic Ocean and intend to incorporate into that analysis new scientific information as well as new information about projected seismic and exploratory drilling activity in both seas. However, AWL and AEWC argue that NEPA regulations make clear that NMFS should not proceed with authorizations for individual projects like Shell's surveying until its programmatic EIS is complete. NSB states that it would be regretful for Shell to proceed on a one-year IHA when the impact of those activities could have a catastrophic impact on Arctic resources and foreclose management options to be developed in the forthcoming EIS.

Response: While the Final PEIS will analyze the affected environment and environmental consequences from seismic surveys in the Arctic, the analysis contained in the Final PEIS will apply more broadly to Arctic oil and gas operations. NMFS' issuance of an IHA to Shell for the taking of several species of marine mammals incidental to conducting its open-water marine survey program in the Chukchi and Beaufort Seas in 2010, as analyzed in the EA, is not expected to significantly affect the quality of the human environment. Shell's surveys are not expected to significantly affect the quality of the human environment because of the limited duration and scope of Shell's operations. Additionally, the EA contained a full analysis of cumulative impacts.

Miscellaneous Issues

Comment 42: The AEWC states that Shell was unable to reach an accord on the annual CAA with AEWC. AEWC states that the CAA has historically formed the basis for NMFS' statutorily required determination of no unmitigable adverse impacts to subsistence activities. Specifically, AEWC states that Shell was not able to reach agreement with AEWC on (1) provisions for zero discharge and (2) on the sound threshold for activities that should be subject to sound source verification procedures. AEWC requests NMFS to fulfill its Congressional mandate and ensure that Shell's activities do not have more than a negligible impact on marine mammal stocks or an unmitigable adverse impact on the subsistence activities. The Commission also recommends that NMFS require Shell to engage in consultations with Alaska Native communities that may be affected by the company's activities and, to the extent feasible, seek to resolve any Alaska Native concerns through negotiation of a CAA.

Response: AEWC states that the CAA has historically formed the basis for NMFS' statutorily required determination of no unmitigable adverse impacts to subsistence activities, which is incorrect. Under sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*), an IHA or LOA shall be granted to U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS finds that the taking of marine mammals will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. In other words, no marine mammal take authorizations may be issued if NMFS has reason to believe that the proposed exploration or development activities would have an unmitigable adverse impact on the availability of marine mammal species or stock(s) for Alaskan native subsistence uses. Although Federal laws do not require consultation with the native coastal communities until after offshore exploration and development plans have been finalized, permitted, and authorized, pre-permitting consultations between the oil and gas industry and the Alaskan coastal native communities are considered by NMFS when the agency makes a determination whether such activities would have an unmitigable adverse impact on the availability of marine mammal species or stock(s) for subsistence uses. For the proposed marine surveys, Shell has conducted POC meetings for its seismic operations in the Beaufort and Chukchi Seas in the communities and villages of Nuiqsut, Kaktovik, Barrow, Kotzebue, Wainwright, Point Lay, and Point Hope.

Shell has not signed the 2010 CAA with Alaska Natives and has informed NMFS that it does not intend to do so. NMFS has scrutinized all of the documents submitted by Shell (*e.g.,* IHA application, Plan of Cooperation and other correspondence to NMFS and affected stakeholders) and documents submitted by other affected stakeholders and concluded that harassment of marine mammals incidental to Shell's activities will not have more than a negligible impact on marine mammal stocks or an unmitigable adverse impact on the availability of marine mammals for taking for subsistence uses. This finding was based in large part on NMFS' definition of "negligible impact," "unmitigable adverse impact," the proposed mitigation and monitoring measures, the scope of activities proposed to be conducted, including time of year, location and presence of marine mammals in the project area, and Shell's Plan of Cooperation.

As described in Shell's IHA application, the source vessel will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. This entry into the Chukchi Sea will not occur before July 1, 2010. In the event the transit outside of the polynya zone results in Shell having to move away from ice, the source vessel may enter into the polynya zone. 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 Com Centers.

Shell has developed a Communication Plan and will implement the plan before initiating the 2010 program 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 Communication and Call Centers to be located in coastal villages along the Beaufort and Chukchi Seas during Shell's program in 2010.

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 may be up to nine subsistence advisor-liaison positions (one per village), to work approximately 8 hours per day and 40-hour weeks through Shell's 2010 program. The subsistence advisor will use local 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 program activities. 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.

Shell will also implement flight restrictions prohibiting aircraft from flying within 1,000 ft (300 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.

Besides bowhead whale hunting, beluga whales are hunted for subsistence at Barrow, Wainwright, Point Lay, and Point Hope, with the most taken by Point Lay (Fuller and George 1997). Harvest at all of these villages generally occurs between April and July with most taken in April and May when pack-ice conditions deteriorate and leads open up. Ringed, bearded, and spotted seals are hunted by all of the villages bordering the project area (Fuller and George 1997). Ringed and bearded seals are hunted throughout the year, but most are taken in May, June, and July when ice breaks up and there is open water instead of the more difficult hunting of seals at holes and lairs. Spotted seals are only hunted in spring through summer.

Therefore, the scheduling of the proposed marine surveys is expected to have minimum conflict between the industries and marine mammal harvests.

Finally, the required mitigation and monitoring measures are expected to reduce any adverse impacts on marine mammals for taking for subsistence uses to the extent practicable. These measures include, but are not limited to, the 180 dB and 190 dB safety (shut-down/power-down) zones; a requirement to monitor the 160 dB isopleths for aggregations of 12 or more non-migratory balaenidae whales and when necessary shut down seismic airguns; reducing vessel speed to 10 knots or less when a vessel is within 300 yards of whales to avoid a collision; utilizing communication centers to avoid any conflict with subsistence hunting activities; and the use of marine mammal observers.

Measures related to "zero volume discharge" do not affect NMFS' negligible determination on impacts of the species or stock(s) or the unmitigable adverse impact determination on the availability of the species or stock(s) for certain subsistence uses, as long as Shell's emission discharge is within the guidelines set by the Environmental Protection Agency (EPA). Regarding the sound source verification (SSV), NMFS requires Shell to conduct SSV tests for all its airgun and active acoustic sources and seismic and support vessels that will be involved in the proposed marine surveys.

Over the past several months, NMFS has worked with both Alaska Native communities and the industry, to the extent feasible, to resolve any Alaska Native concerns from the proposed open water marine and seismic surveys. These efforts include convening an open water stakeholders' meeting in Anchorage, AK, in March 2010, and multiple conference meetings with representatives of the Alaska Native communities and the industry. Lastly, as mentioned previously in this document, NMFS has included several measures from the CAA in the IHA issued to Shell.

Comment 43: AEWC notes that, in 2009, NMFS did not publish its response to comments on proposed IHAs activities conducted during the open water season until well after the fall subsistence hunt at Cross Island had concluded and geophysical operations had already taken place. AEWC states that NMFS' failure to release its response to comments until after the activities had taken place casts serious doubt on the validity of NMFS' public involvement process and the underlying analysis of impacts to subsistence activities and marine mammals.

Response: NMFS does not agree with AEWC's statement that NMFS' failure to release its response to comments until after the activities had taken place casts doubt on the validity of NMFS' public involvement process, or the underlying analysis of impacts to subsistence activities and marine mammals. As stated earlier, the decision to issue an IHA to Shell for its proposed marine surveys in the Beaufort and Chukchi Seas is based in large part on NMFS' definition of "negligible impact," "unmitigable adverse impact," the proposed mitigation and monitoring measures, the scope of activities proposed to be conducted, including time of year, location and presence of marine mammals in the project area, extensive research and studies on potential impacts of anthropogenic sounds to marine mammals, marine mammal behavior, distribution, and movements in the vicinity of Shell's proposed project areas, Shell's Plan of Cooperation, and on public comments received during the commenting period and peer-review recommendations by an independent review panel. The reason that NMFS was not able to publish its response to comments on proposed IHA activities in 2009 for Shell's shallow hazards and site clearance surveys until the end of the survey activities was due to the large amount of comments NMFS received. NMFS was able to review and analyze all comments it received and address their validity for the issuance of the IHA. However, due to the large volume of comments, NMFS was not able to organize them into publishable format to be incorporated into the **Federal Register** notice for publication on a timely basis. NMFS will strive to make sure that all comments are addressed in full and published by the time IHAs or LOAs are issued.

Comment 44: AEWC states that Shell failed to provide plans for community engagement. AEWC states that Shell is required to include in its application a "schedule for meeting with affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation." (50 CFR 216.104(a)(12)(ii)). However, AEWC notes that in its application, Shell only just mentions that it held a few meetings and "anticipates continued engagement." AEWC argues that this vague intention to participate in more meetings with the affected communities is insufficient and does not satisfy the regulatory requirement. AEWC points out that Shell is also required to provide its plans for continuing to meet with communities. AEWC notes that while Shell mentions communicating with communities via its SA and Com and

Call Center program, which allows for the availability of back and forth communication, the company has described no actual, planned communication with the affected communities.

Response: The information AEWC contained in the comment is outdated. Since the submission of Shell's IHA application, Shell indicated that it completed its pre-season Plan of Cooperation meetings for the 2010 season in early April 2010. Through the Subsistence Advisor (SA) and Com and Call Center (Com Center) program for 2010, Shell's SA and Shell representatives in the Com Centers will be available daily to the communities throughout the 2010 season. The SA and Com Center programs provide residents of the nearest affected communities a way to communicate where and when subsistence activities occur so that industry may avoid conflicts with planned subsistence activities.

Comment 45: NSB states that NMFS should consider and address disproportionate impacts in analyzing the IHA application, that Federal agencies must "make achieving environmental justice part of * * * [their] mission[s]." Compared to many United States residents, NSB states that Alaskan Natives face significant impacts from oil and gas activities in the OCS. NSB requests that NMFS thus specifically address issues of environmental justice in considering this application and that NMFS must also work to ensure effective public participation and access to information, and must "ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public."

Response: Under section 101(a)(5)(D) of the MMPA, NMFS is required to determine whether the taking by the applicant's specified activity will take only small numbers of marine mammals, will have a negligible impact on the affected marine mammal species or population stocks, and will not have an unmitigable impact on the availability of affected species or stocks for subsistence uses. Environmental justice and other impacts to the human environment are NMFS' responsibility under the NEPA and applicable executive orders, not the MMPA. In that regard, NMFS' 2010 EA addresses the potential cumulative impacts to the socioeconomic environment, including traditional knowledge, community and economy of the Alaskan Arctic, subsistence harvesting, and coastal and marine use issues. Please refer to NMFS' 2010 EA for these assessments.

In addition, NMFS has been working with the public to ensure public participation, which includes the public review and comments on Shell's IHA application and the proposed IHA. All documents related to this action are available through the NMFS Office of Protected Resources Web site at *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*.

Description of Marine Mammals in the Area of the Specified Activity

Nine cetacean and four pinniped species under NMFS jurisdiction could occur in the general area of Shell's open water marine survey areas in the Beaufort and Chukchi Seas. The species most likely to occur in the general area near Harrison Bay in the Alaskan Beaufort Sea include two cetacean species: Beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*) and three seal species: Ringed (*Phoca hispida*), spotted (*P. largha*), and bearded seals (*Erignathus barbatus*). Most encounters are likely to occur in nearshore shelf habitats or along the ice edge. The marine mammal species that is likely to be encountered most widely (in space and time) throughout the period of the planned shallow hazards surveys is the ringed seal. Encounters with bowhead and beluga whales are expected to be limited to particular regions and seasons, as discussed below.

Other marine mammal species that have been observed in the Beaufort and Chukchi Seas but are less frequent or uncommon in the Beaufort Sea project area include harbor porpoise (*Phocoena phocoena*), narwhal (*Monodon monoceros*), killer whale (*Orcinus orca*), fin whale (*Balaenoptera physalus*), minke whale (*B. acutorostrata*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), and ribbon seal (*Histriophoca fasciata*). 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 proposed marine surveys. 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, fin, 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).

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 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.

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. 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*.

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 convened an independent peer review panel to review Shell's Marine Mammal Monitoring and Mitigation Plan (4MP) for the Open Water Marine Survey Program in the Beaufort and Chukchi Seas, Alaska, during 2010. The panel met on March 25 and 26, 2010, and provided their final report to NMFS on April 22, 2010. The full panel report can be viewed at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.*

NMFS provided the panel with Shell's 4MP and asked the panel to address the following questions and issues for Shell's plan:

(1) The monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

(2) Ensure that the monitoring activities and methods described in the plan will enable the applicant to meet the requirements listed in (1) above;

(3) Are the applicant's objectives achievable based on the methods described in the plan?

(4) Are the applicant's objectives the most useful for understanding impacts on marine mammals?

(5) Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity? And

(6) What is the best way for an applicant to report their data and results to NMFS?

Section 3 of the report contains recommendations that the panel members felt were applicable to all of the monitoring plans reviewed this year. Section 4.4 of the report contains recommendations specific to Shell's Open Water Marine Survey Program 4MP. Specifically, for the general recommendations, the panel commented on issues related to: (1) Acoustic effects of oil and gas exploration—assessment and mitigation; (2) aerial surveys; (3) MMOs; (4) visual near-field monitoring; (5) visual far-field monitoring; (6) baseline biological and environmental information; (7) comprehensive ecosystem assessments and cumulative impacts; (8) duplication of seismic survey effort; and (9) whale behavior.

NMFS has reviewed the report and evaluated all recommendations made by the panel. NMFS has determined that there are several measures that Shell can incorporate into its 2010 Open Water Marine Survey Program 4MP to improve it. Additionally, there are other recommendations that NMFS has determined would also result in better data collection, and could potentially be implemented by oil and gas industry applicants, but which likely could not be implemented for the 2010 open water season due to technical issues (*see* below). While it may not be possible to implement those changes this year, NMFS believes that they are worthwhile and appropriate suggestions that may require a bit more time to implement, and Shell should consider incorporating them into future monitoring plans should Shell decide to apply for IHAs in the future.

The following subsections lay out measures that NMFS recommends for implementation as part of the 2010 Open Water Marine Survey Program 4MP and those that are recommended for future programs.

Recommendations for Inclusion in the 2010 4MP and IHA

Section 3.3 of the panel report contains several recommendations regarding MMOs, which NMFS agrees that Shell should incorporate:

- Observers should be trained using visual aids (*e.g.,* videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.
- Observers should understand the importance of classifying marine mammals as "unknown" or "unidentified" if they cannot identify the animals to species with confidence. In those cases, they should note any information that might aid in the identification of the marine mammal sighted. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.
- Observers should attempt to maximize the time spent looking at the water and guarding the safety radii. They should avoid the tendency to spend too much time evaluating animal behavior or entering data on forms, both of which detract from their primary purpose of monitoring the safety zone.
- 'Big eye' binoculars (25×150) should be used from high perches on large, stable platforms. They are most useful for monitoring impact zones that extend beyond the effective line of sight. With two or three observers on watch, the use of 'big eyes' should be paired with searching by naked eye, the latter allowing visual coverage of nearby areas to detect marine mammals. When a single observer is on duty, the observer should follow a regular schedule of shifting between searching by naked-eye, low-power binoculars, and big-eye binoculars based on the activity, the environmental conditions, and the marine mammals of concern.
- Observers should use the best possible positions for observing (*e.g.,* outside and as high on the vessel as possible), taking into account weather and other working conditions.
- Whenever possible, new observers should be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations. If there are Alaska Native MMOs, the MMO training that is conducted prior to the start of the survey activities should be conducted with both Alaska Native MMOs and biologist MMOs being trained at the same time in the same room. There should not be separate training courses for the different MMOs.

In Section 3.4, panelists recommend collecting some additional data to help verify the utility of the "ramp-up" requirement commonly contained in IHAs. To help evaluate the utility of ramp-up procedures, NMFS will require observers to record and report their observations during any ramp-up period. An analysis of these observations may lead to the conclusion regarding the effectiveness of ramp-up and should be included in the monitoring report.

Among other things, Section 3.5 of the panel report recommends recording visibility data because of the concern that the line-of-sight distance for observing marine mammals is reduced under certain conditions. MMOs should "carefully document visibility during observation periods so that total estimates of take can be corrected accordingly".

Section 4.4 of the report contains recommendations specific to Shell's Open Water Marine Survey Program 4MP. Of the recommendations presented in this section, NMFS has determined that the following should be implemented for the 2010 season:

- Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, the company's activity at the time, each animal's response, and any adjustments made to operating procedures. Provide all spatial data on charts (always including vessel location).
- Make all data available in the report or (preferably) electronically for integration with data from other companies.
- Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are

introduced into the environment by the operation.

NMFS spoke with Shell about the inclusion of these recommendations into the 2010 4MP and IHA. Shell indicated to NMFS that they will incorporate these recommendations into the 4MP, and NMFS has made several of these recommendations requirements in the IHA.

Recommendations for Inclusion in Future Monitoring Plans

Section 3.5 of the report recommends methods for conducting comprehensive monitoring of a large-scale seismic operation. One method for conducting this monitoring recommended by panel members is the use of passive acoustic devices. Additionally, Section 3.2 of the report encourages the use of such systems if aerial surveys will not be used for real-time mitigation monitoring. NMFS acknowledges that there are challenges involved in using this technology to detect bowhead whale vocalizations in conjunction with seismic airguns in this environment, especially in real time. However, NMFS recommends that Shell work to help develop and improve this type of technology for use in the Arctic (and use it once it is available and effective), as it could be valuable both for real-time mitigation implementation, as well as archival data collection. Shell indicated to NMFS that they have been working for several years to aid in the development of such technology and will continue to do so.

The panelists also recommend adding a tagging component to monitoring plans. "Tagging of animals expected to be in the area where the survey is planned also may provide valuable information on the location of potentially affected animals and their behavioral responses to industrial activities. Although the panel recognized that such comprehensive monitoring might be difficult and expensive, such an effort (or set of efforts) reflects the complex nature of the challenge of conducting reliable, comprehensive monitoring for seismic or other relatively-intense industrial operations that ensonify large areas of ocean." While this particular recommendation is not feasible for implementation in 2010, NMFS recommends that Shell consider adding a tagging component to future seismic survey monitoring plans should Shell decide to conduct such activities in future years. Shell currently helps to fund the U.S. Geological Survey's walrus tagging project in the Arctic and is open to the idea of helping to fund other marine mammal tagging projects in the Arctic.

To the extent possible, NMFS recommends implementing the recommendation contained in Section 4.4.6 for the 2010 season: "Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey." However, NMFS recognizes that this integration process may take time to implement. Therefore, Shell should begin considering methods for the integration of the observer data now if Shell intends to apply for IHAs in the future.

In Section 3.4, panelists recommend collecting data to evaluate the efficacy of using forward-looking infrared devices (FLIR) vs. night-vision binoculars. The panelists note that while both of these devices may increase detection capabilities by MMOs of marine mammals, the reliability of these technologies should be tested under appropriate conditions and their efficacy evaluated. NMFS recommends that Shell design a study to explore using both FLIR and night-vision binoculars and collect data on levels of detection of marine mammals using each type of device.

Other Recommendations in the Report

The panel also made several recommendations, which are not discussed in the two preceding subsections. NMFS determined that many of the recommendations were made beyond the bounds of what the panel members were tasked to do. For example, the panel recommended that NMFS begin a transition away from using a single metric of acoustic exposure to estimate the potential effects of anthropogenic sound on marine living resources. This is not a recommendation about monitoring but rather addresses a NMFS policy issue. NMFS is currently in the process of revising its acoustic guidelines on a national scale. A recommendation was also made regarding the training and oversight of MMOs. NMFS is currently working on a national policy for this as well Section 3.7 of the report contains several recommendations regarding comprehensive ecosystem assessments and cumulative impacts. These are good, broad recommendations, however, the implementation of these recommendations would not be the responsibility solely of oil and gas industry applicants. The recommendations require the cooperation and input of several groups, including Federal, state, and local government agencies, members of other industries, and members of the scientific research community. NMFS will encourage the industry and others to build the relationships and infrastructure necessary to pursue these goals, and incorporate these recommendations into future MMPA authorizations, as appropriate. Lastly, Section 3.8 of the report makes a recommendation regarding data sharing and reducing the duplication of seismic survey effort. While this is a valid recommendation, it does not relate to monitoring or address any of the six questions with which the panel members were tasked to answer.

For some of the recommendations, NMFS felt that additional clarification was required by the panel members before NMFS could determine whether or not applicants should incorporate them into the monitoring plans. Section 3.2 of the report discusses the use of and methods for conducting aerial surveys. Industry applicants have not conducted aerial surveys in Chukchi Sea lease sale areas for several years because of the increased risk for flying there (as noted by the panel report). To that end, NMFS has asked the panel to provide recommendations on whether or not similar surveys could be conducted from dedicated vessel-based platforms. NMFS also asked for additional clarification on some of the recommendations regarding data collection and take estimate calculations. In addition, NMFS asked the panel members for clarification on the recommendation contained in Section 3.6 regarding baseline studies. Lastly, NMFS asked the panel members for clarification on the recommendation specific to Shell contained in Section 4.4 regarding estimating statistical power for all methods intended to detect adverse impacts. Once NMFS hears back from the panel and is clear with these recommendations, NMFS will follow up with Shell and discuss the implementation of these additional measures in future years.

Potential Effects of the Specified Activity on Marine Mammals

Operating a variety of active acoustic sources such as airguns, side-scan sonars, echo-sounders, and sub-bottom profilers for site clearance and shallow hazard surveys, ice gouge, and strudel surveys can impact marine mammals in a variety of ways.

Potential Effects of Airgun and Sonar Sounds on Marine Mammals

The effects of sounds from airgun pulses might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and

temporary or permanent hearing impairment or non-auditory effects (Richardson *et al.* 1995). 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.* 1995):

(1) Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Numerous studies have also shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed 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 airgun pulses under some conditions, at other times, mammals of all three types have shown no overt reactions. In general, pinnipeds and small odontocetes seem to be more tolerant of exposure to airgun pulses than baleen whales.

(2) Behavioral Disturbance

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

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

- Drastic change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cease feeding or social interaction.

For example, at the Guerreo Negro Lagoon in Baja California, Mexico, which is one of the important breeding grounds for Pacific gray whales, shipping and dredging associated with a salt works may have induced gray whales to abandon the area through most of the 1960s (Bryant *et al.* 1984). After these activities stopped, the lagoon was reoccupied, first by single whales and later by cow-calf pairs.

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

Currently NMFS uses 160 dB re 1 µPa at received level for impulse noises (such as airgun pulses) as the onset of marine mammal behavioral harassment.

Mysticete: Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to airgun pulses at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances (reviewed in Richardson *et al.* 1995; Gordon *et al.* 2004). However, studies done since the late 1990s of migrating humpback and migrating bowhead whales show reactions, including avoidance, that sometimes extend to greater distances than documented earlier. Avoidance distances often exceed the distances at which boat-based observers can *see* whales, so observations from the source vessel can be biased. Observations over broader areas may be needed to determine the range of potential effects of some large-source seismic surveys where effects on cetaceans may extend to considerable distances (Richardson *et al.* 1999; Moore and Angliss 2006). Longer-range observations, when required, can sometimes be obtained via systematic aerial surveys or aircraft-based observations of behavior (*e.g.,* Richardson *et al.* 1986, 1999; Miller *et al.* 1999, 2005; Yazvenko *et al.* 2007a, 2007b) or by use of observers on one or more support vessels operating in coordination with the seismic vessel (*e.g.,* Smultea *et al.* 2004; Johnson *et al.* 2007). However, the presence of other vessels near the source vessel can, at least at times, reduce sightability of cetaceans from the source vessel (Beland *et al.* 2009), thus complicating interpretation of sighting data.

Some baleen whales show considerable tolerance of seismic pulses. However, when the pulses are strong enough, avoidance or other behavioral changes become evident. Because the responses become less obvious with diminishing received sound level, it has been difficult to determine the maximum distance (or minimum received sound level) at which reactions to seismic become evident and, hence, how many whales are affected.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 µPa (rms) range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (*see* review in Southall *et al.* 2007). In many areas, seismic pulses diminish to these levels at distances ranging from 4–15 km from the source. A substantial proportion of the baleen whales within such distances may show avoidance or other strong disturbance reactions to the operating airgun array. However, in other situations, various mysticetes tolerate exposure to full-scale airgun arrays operating at even closer distances, with only localized avoidance and minor changes in activities. At the other extreme, in migrating bowhead whales, avoidance often extends to considerably larger distances (20–30 km) and lower received sound levels (120–130 dB re 1 µPa (rms)). Also, even in cases where there is no conspicuous avoidance or change in activity upon exposure to sound pulses from distant seismic operations, there are sometimes subtle changes in behavior (*e.g.,* surfacing-respiration-dive cycles) that are only evident through detailed statistical analysis (*e.g.,* Richardson *et al.* 1986; Gailey *et al.* 2007).

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

notably (Allen and Angliss 2010). Bowheads also have been observed over periods of days or weeks in areas ensonified repeatedly by seismic pulses (Richardson *et al.* 1987; Harris *et al.* 2007). However, it is generally not known whether the same individual bowheads were involved in these repeated observations (within and between years) in strongly ensonified areas. In any event, in the absence of some unusual circumstances, the history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

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

Dolphins and porpoises are often seen by observers on active seismic vessels, occasionally at close distances (*e.g.,* bow riding). However, some studies near the U.K., Newfoundland and Angola, in the Gulf of Mexico, and off Central America have shown localized avoidance. Also, belugas summering in the Canadian Beaufort Sea showed larger-scale avoidance, tending to avoid waters out to 10–20 km from operating seismic vessels. In contrast, recent studies show little evidence of conspicuous reactions by sperm whales to airgun pulses, contrary to earlier indications.

There are almost no specific data on responses of beaked whales to seismic surveys, but it is likely that most if not all species show strong avoidance. There is increasing evidence that some beaked whales may strand after exposure to strong noise from tactical military mid-frequency sonars. Whether they ever do so in response to seismic survey noise is unknown. Northern bottlenose whales seem to continue to call when exposed to pulses from distant seismic vessels.

For delphinids, and possibly the Dall's porpoise, the available data suggest that a ≥170 dB re 1 μPa (rms) disturbance criterion (rather than ≥160 dB) would be appropriate. With a medium-to-large airgun array, received levels typically diminish to 170 dB within 1–4 km, whereas levels typically remain above 160 dB out to 4–15 km (*e.g.,* Tolstoy et al. 2009). Reaction distances for delphinids are more consistent with the typical 170 dB re 1 μParms distances.

Due to their relatively higher frequency hearing ranges when compared to mysticetes, odontocetes may have stronger responses to mid- and high-frequency sources such as sub-bottom profilers, side scan sonar, and echo sounders than mysticetes (Richardson *et al.* 1995; Southall *et al.* 2007). Although the mid- and high-frequency active acoustic sources with operating frequency between 2 and 50 kHz planned to be used by Shell have much lower power outputs (167–200 dB re 1 μPa @ 1 m at source level) than those from the airguns, they could cause mild behavior reactions to odontocete whales because their operating frequencies fall within the sensitive hearing range of these animals. However, scientific information is lacking on specific behavioral responses by odontocetes to mid- and high-frequency sources. Nevertheless, based on our current knowledge on mysticete reaction towards low-frequency airgun pulses, we could induce that more or less similar reactions could be exhibited by odontocete whales towards mid- and high-frequency sources.

Pinnipeds: Few studies of the reactions of pinnipeds to noise from open-water seismic exploration have been published (for review of the early literature, *see* Richardson *et al.* 1995). However, pinnipeds have been observed during a number of seismic monitoring studies. Monitoring in the Beaufort Sea during 1996–2002 provided a substantial amount of information on avoidance responses (or lack thereof) and associated behavior. Additional monitoring of that type has been done in the Beaufort and Chukchi Seas in 2006–2009. Pinnipeds exposed to seismic surveys have also been observed during seismic surveys along the U.S. west coast. Some limited data are available on physiological responses of pinnipeds exposed to seismic sound, as studied with the aid of radio telemetry. Also, there are data on the reactions of pinnipeds to various other related types of impulsive sounds.

Early observations provided considerable evidence that pinnipeds are often quite tolerant of strong pulsed sounds. During seismic exploration off Nova Scotia, gray seals exposed to noise from airguns and linear explosive charges reportedly did not react strongly (J. Parsons in Greene *et al.* 1985). An airgun caused an initial startle reaction among South African fur seals but was ineffective in scaring them away from fishing gear. Pinnipeds in both water and air sometimes tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding or reproduction (Mate and Harvey 1987; Reeves *et al.* 1996). Thus, pinnipeds are expected to be rather tolerant of, or to habituate to, repeated underwater sounds from distant seismic sources, at least when the animals are strongly attracted to the area.

In summary, visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. These studies show that many pinnipeds do not avoid the area within a few hundred meters of an operating airgun array. However, based on the studies with large sample size, or observations from a separate monitoring vessel, or radio telemetry, it is apparent that some phocid seals do show localized avoidance of operating airguns. The limited nature of this tendency for avoidance is a concern. It suggests that one cannot rely on pinnipeds to move away, or to move very far away, before received levels of sound from an approaching seismic survey vessel approach those that may cause hearing impairment.

(3) Masking

Chronic exposure to excessive, though not high-intensity, noise could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Since marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that experience severe acoustic masking will have reduced fitness in survival and reproduction.

Masking occurs when noise and signals (that animal utilizes) overlap at both spectral and temporal scales. For the airgun noise generated from the proposed marine seismic survey, these are low frequency (under 1 kHz) pulses with extremely short durations (in the scale of milliseconds). Lower frequency man-made noises are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise.

There is little concern regarding masking due to the brief duration of these pulses and relatively longer silence between airgun shots (9–12 seconds) near the noise source, however, at long distances (over tens of kilometers away) in deep water, due to multipath propagation and reverberation, the durations of airgun pulses can be "stretched" to seconds with long decays (Madsen *et al.* 2006; Clark and Gagnon 2006). Therefore it could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (*e.g.,* Clark *et al.* 2009a, 2009b) and cause increased stress levels (*e.g.,* Foote *et al.* 2004; Holt *et al.* 2009). Further, in areas of shallow water, multipath propagation of airgun pulses could be more profound, thus affecting communication signals from marine mammals even at close distances. Nevertheless, the intensity of the noise is also greatly reduced at such long distances.

Although masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, there are few specific studies on this. Some whales continue calling in the presence of seismic pulses and whale calls often can be heard between the seismic pulses (*e.g.,* Richardson *et al.* 1986; McDonald *et al.* 1995; Greene *et al.* 1999a, 1999b; Nieukirk *et al.* 2004; Smultea *et al.* 2004; Holst *et al.* 2005a, 2005b, 2006; Dunn and Hernandez 2009). However, there is one recent summary report indicating that calling fin whales distributed in one part of the North Atlantic went silent for an extended period starting soon after the onset of a seismic survey in the area (Clark and Gagnon 2006). It is not clear from that preliminary paper whether the whales ceased calling because of masking, or whether this was a behavioral response not directly involving masking. Also, bowhead whales in the Beaufort Sea may decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate (Blackwell *et al.* 2009a; 2009b).

Among the odontocetes, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles *et al.* 1994). However, more recent studies of sperm whales found that they continued calling in the presence of seismic pulses (Madsen *et al.* 2002; Tyack *et al.* 2003; Smultea *et al.* 2004; Holst *et al.* 2006; Jochens *et al.* 2008). Madsen *et al.* (2006) noted that airgun sounds would not be expected to mask sperm whale calls given the intermittent nature of airgun pulses. Dolphins and porpoises are also commonly heard calling while airguns are operating (Gordon *et al.* 2004; Smultea *et al.* 2004; Holst *et al.* 2005a, 2005b; Potter *et al.* 2007). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocetes, given the intermittent nature of seismic pulses plus the fact that sounds important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds.

Pinnipeds have best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pulses presumably reduces the potential for masking.

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies, increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio and Clark 2009). The North Atlantic right whales (*Eubalaena glacialis*) exposed to high shipping noise increase call frequency (Parks *et al.* 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *et al.* 2000).

(4) Hearing Impairment

Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak *et al.* 1999; Schlundt *et al.* 2000; Finneran *et al.* 2002; 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is unrecoverable, or temporary (TTS), in which case the animal's hearing threshold will recover over time (Southall *et al.* 2007). Just like masking, marine mammals that suffer from PTS or TTS will have reduced fitness in survival and reproduction, either permanently or temporarily. Repeated noise exposure that leads to TTS could cause PTS. For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound.

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. It is a temporary phenomenon, and (especially when mild) is not considered to represent physical damage or "injury" (Southall *et al.* 2007). Rather, the onset of TTS is an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility.

The magnitude of TTS depends on the level and duration of noise exposure, and to some degree on frequency, among other considerations (Kryter 1985; Richardson *et al.* 1995; Southall *et al.* 2007). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. In terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. Only a few data have been obtained on sound levels and durations necessary to elicit mild TTS in marine mammals (none in mysticetes), and none of the published data concern TTS elicited by exposure to multiple pulses of sound during operational seismic surveys (Southall *et al.* 2007).

For toothed whales, experiments on a bottlenose dolphin (*Tursiops truncates*) and beluga whale showed that exposure to a single watergun impulse at a received level of 207 kPa (or 30 psi) peak-to-peak (p-p), which is equivalent to 228 dB re 1 µPa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran *et al.* 2002). No TTS was observed in the bottlenose dolphin.

Finneran *et al.* (2005) further examined the effects of tone duration on TTS in bottlenose dolphins. Bottlenose dolphins were exposed to 3 kHz tones (non-impulsive) for periods of 1, 2, 4 or 8 seconds (s), with hearing tested at 4.5 kHz. For 1-s exposures, TTS occurred with SELs of 197 dB, and for exposures >1 s, SEL >195 dB resulted in TTS (SEL is equivalent to energy flux, in dB re 1 μPa^2-s). At an SEL of 195 dB, the mean TTS (4 min after exposure) was 2.8 dB. Finneran *et al.* (2005) suggested that an SEL of 195 dB is the likely threshold for the onset of TTS in dolphins and belugas exposed to tones of durations 1–8 s (*i.e.,* TTS onset occurs at a near-constant SEL, independent of exposure duration). That implies that, at least for non-impulsive tones, a doubling of exposure time results in a 3 dB lower TTS threshold.

However, the assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification. Kastak *et al.* (2005) reported preliminary

evidence from pinnipeds that, for prolonged non-impulse noise, higher SELs were required to elicit a given TTS if exposure duration was short than if it was longer, *i.e.,* the results were not fully consistent with an equal-energy model to predict TTS onset. Mooney *et al.* (2009a) showed this in a bottlenose dolphin exposed to octave-band non-impulse noise ranging from 4 to 8 kHz at SPLs of 130 to 178 dB re 1 μPa for periods of 1.88 to 30 minutes (min). Higher SELs were required to induce a given TTS if exposure duration was short than if it was longer. Exposure of the aforementioned bottlenose dolphin to a sequence of brief sonar signals showed that, with those brief (but non-impulse) sounds, the received energy (SEL) necessary to elicit TTS was higher than was the case with exposure to the more prolonged octave-band noise (Mooney *et al.* 2009b). Those authors concluded that, when using (non-impulse) acoustic signals of duration ~0.5 s, SEL must be at least 210–214 dB re 1 μPa2-s to induce TTS in the bottlenose dolphin. The most recent studies conducted by Finneran *et al.* also support the notion that exposure duration has a more significant influence compared to SPL as the duration increases, and that TTS growth data are better represented as functions of SPL and duration rather than SEL alone (Finneran *et al.* 2010a, 2010b). In addition, Finneran *et al.* (2010b) conclude that when animals are exposed to intermittent noises, there is recovery of hearing during the quiet intervals between exposures through the accumulation of TTS across multiple exposures. Such findings suggest that when exposed to multiple seismic pulses, partial hearing recovery also occurs during the seismic pulse intervals.

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 ambient noise levels at those low frequencies tend to be higher (Urick 1983). As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales. However, no cases of TTS are expected given the small size of the airguns proposed to be used and the strong likelihood that baleen whales (especially migrating bowheads) would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS.

In pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.* 1999; 2005). However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal, which is closely related to the ringed seal) may occur at a similar SEL as in odontocetes (Kastak *et al.* 2004).

Most cetaceans show some degree of avoidance of seismic vessels operating an airgun array (*see* above). It is unlikely that these cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the vessel and the marine mammal. TTS would be more likely in any odontocetes that bow- or wake-ride or otherwise linger near the airguns. However, while bow- or wake-riding, odontocetes would be at the surface and thus not exposed to strong sound pulses given the pressure release and Lloyd Mirror effects at the surface. But if bow- or wake-riding animals were to dive intermittently near airguns, they would be exposed to strong sound pulses, possibly repeatedly.

If some cetaceans did incur mild or moderate TTS through exposure to airgun sounds in this manner, this would very likely be a temporary and reversible phenomenon. However, even a temporary reduction in hearing sensitivity could be deleterious in the event that, during that period of reduced sensitivity, a marine mammal needed its full hearing sensitivity to detect approaching predators, or for some other reason.

Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent as those of cetaceans. Pinnipeds occasionally seem to be attracted to operating seismic vessels. There are no specific data on TTS thresholds of pinnipeds exposed to single or multiple low-frequency pulses. However, given the indirect indications of a lower TTS threshold for the harbor seal than for odontocetes exposed to impulse sound (*see* above), it is possible that some pinnipeds close to a large airgun array could incur TTS.

Current NMFS' noise exposure standards require 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). These criteria were taken from recommendations by an expert panel of the High Energy Seismic Survey (HESS) Team that performed an assessment on noise impacts by seismic airguns to marine mammals in 1997, although the HESS Team recommended a 180-dB limit for pinnipeds in California (HESS 1999). The 180 and 190 dB re 1 μPa (rms) levels have not been considered to be the levels above which TTS might occur. Rather, they were 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. As summarized above, data that are now available imply that TTS is unlikely to occur in various odontocetes (and probably mysticetes as well) unless they are exposed to a sequence of several airgun pulses stronger than 190 dB re 1 μPa (rms). On the other hand, for the harbor seal, harbor porpoise, and perhaps some other species, TTS may occur upon exposure to one or more airgun pulses whose received level equals the NMFS "do not exceed" value of 190 dB re 1 μPa (rms). That criterion corresponds to a single-pulse SEL of 175–180 dB re 1 μPa^2-s in typical conditions, whereas TTS is suspected to be possible in harbor seals and harbor porpoises with a cumulative SEL of ~171 and ~164 dB re 1 μPa^2-s, respectively.

It has been shown that most large whales and many smaller odontocetes (especially the harbor porpoise) show at least localized avoidance of ships and/or seismic operations. Even when avoidance is limited to the area within a few hundred meters of an airgun array, that should usually be sufficient to avoid TTS based on what is currently known about thresholds for TTS onset in cetaceans. In addition, ramping up airgun arrays, which is standard operational protocol for many seismic operators, should allow cetaceans near the airguns at the time of startup (if the sounds are aversive) to move away from the seismic source and to avoid being exposed to the full acoustic output of the airgun array. Thus, most baleen whales likely will not be exposed to high levels of airgun sounds provided the ramp-up procedure is applied. Likewise, many odontocetes close to the

trackline are likely to move away before the sounds from an approaching seismic vessel become sufficiently strong for there to be any potential for TTS or other hearing impairment. Hence, there is little potential for baleen whales or odontocetes that show avoidance of ships or airguns to be close enough to an airgun array to experience TTS. Therefore, it is not likely that marine mammals in the vicinity of the proposed open water marine and seismic surveys by Shell and Statoil would experience TTS as a result of these activities.

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 (Kryter 1985). Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times. (Rise time is the interval required for sound pressure to increase from the baseline pressure to peak pressure.)

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS (*see* above), there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (*e.g.,* Richardson *et al.* 1995; Gedamke *et al.* 2008). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals (Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably >6 dB higher (Southall *et al.* 2007). The low-to-moderate levels of TTS that have been induced in captive odontocetes and pinnipeds during controlled studies of TTS have been confirmed to be temporary, with no measurable residual PTS (Kastak *et al.* 1999; Schlundt *et al.* 2000; Finneran *et al.* 2002; 2005; Nachtigall *et al.* 2003; 2004). However, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter 1985). In terrestrial mammals, the received sound level from a single non-impulsive sound exposure must be far above the TTS threshold for any risk of permanent hearing damage (Kryter 1994; Richardson *et al.* 1995; Southall *et al.* 2007). However, there is special concern about strong sounds whose pulses have very rapid rise times. In terrestrial mammals, there are situations when pulses with rapid rise times (*e.g.,* from explosions) can result in PTS even though their peak levels are only a few dB higher than the level causing slight TTS. The rise time of airgun pulses is fast, but not as fast as that of an explosion.

Some factors that contribute to onset of PTS, at least in terrestrial mammals, are as follows:

- Exposure to single very intense sound,
- Fast rise time from baseline to peak pressure,
- Repetitive exposure to intense sounds that individually cause TTS but not PTS, and
- Recurrent ear infections or (in captive animals) exposure to certain drugs.

Cavanagh (2000) reviewed the thresholds used to define TTS and PTS. Based on this review and SACLANT (1998), it is reasonable to assume that PTS might occur at a received sound level 20 dB or more above that inducing mild TTS. However, for PTS to occur at a received level only 20 dB above the TTS threshold, the animal probably would have to be exposed to a strong sound for an extended period, or to a strong sound with rather rapid rise time.

More recently, Southall *et al.* (2007) estimated that received levels would need to exceed the TTS threshold by at least 15 dB, on an SEL basis, for there to be risk of PTS. Thus, for cetaceans exposed to a sequence of sound pulses, they estimate that the PTS threshold might be an M-weighted SEL (for the sequence of received pulses) of ~198 dB re 1 μPa^2-s. Additional assumptions had to be made to derive a corresponding estimate for pinnipeds, as the only available data on TTS-thresholds in pinnipeds pertained to nonimpulse sound (*see* above). Southall *et al.* (2007) estimated that the PTS threshold could be a cumulative SEL of ~186 dB re 1 μPa^2-s in the case of a harbor seal exposed to impulse sound. The PTS threshold for the California sea lion and northern elephant seal would probably be higher given the higher TTS thresholds in those species. Southall *et al.* (2007) also note that, regardless of the SEL, there is concern about the possibility of PTS if a cetacean or pinniped received one or more pulses with peak pressure exceeding 230 or 218 dB re 1 µPa, respectively. Thus, PTS might be expected upon exposure of cetaceans to either SEL ≥198 dB re 1 µPa2-s or peak pressure ≥230 dB re 1 µPa. Corresponding proposed dual criteria for pinnipeds (at least harbor seals) are ≥186 dB SEL and ≥ 218 dB peak pressure (Southall *et al.* 2007). These estimates are all first approximations, given the limited underlying data, assumptions, species differences, and evidence that the "equal energy" model may not be entirely correct.

Sound impulse duration, peak amplitude, rise time, number of pulses, and inter-pulse interval are the main factors thought to determine the onset and extent of PTS. Ketten (1994) has noted that the criteria for differentiating the sound pressure levels that result in PTS (or TTS) are location and species specific. PTS effects may also be influenced strongly by the health of the receiver's ear.

As described above for TTS, in estimating the amount of sound energy required to elicit the onset of TTS (and PTS), it is assumed that the auditory effect of a given cumulative SEL from a series of pulses is the same as if that amount of sound energy were received as a single strong sound. There are no data from marine mammals concerning the occurrence or magnitude of a potential partial recovery effect between pulses. In deriving the estimates of PTS (and TTS) thresholds quoted here, Southall *et al.* (2007) made the precautionary assumption that no recovery would occur between pulses.

It is unlikely that an odontocete would remain close enough to a large airgun array for sufficiently long to incur PTS. There is some concern about bowriding odontocetes, but for animals at or near the surface, auditory effects are reduced by Lloyd's mirror and surface release effects. The presence of the vessel between the airgun array and bow-riding odontocetes could also, in some but probably not all cases, reduce the levels received by bow-riding animals (*e.g.,* Gabriele and Kipple 2009). The TTS (and thus PTS) thresholds of baleen whales are unknown but, as an interim measure, assumed to be no lower than those of odontocetes. Also, baleen whales generally avoid the immediate area around operating seismic vessels, so it is unlikely that a baleen whale could incur PTS from exposure to airgun pulses. The TTS (and thus PTS) thresholds of some pinnipeds (*e.g.,* harbor seal) as well as the harbor

porpoise may be lower (Kastak *et al.* 2005; Southall *et al.* 2007; Lucke *et al.* 2009). If so, TTS and potentially PTS may extend to a somewhat greater distance for those animals. Again, Lloyd's mirror and surface release effects will ameliorate the effects for animals at or near the surface.

(5) Non-Auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (*i.e.,* beaked whales) may be especially susceptible to injury and/or stranding when exposed to intense sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns, and beaked whales do not occur in the proposed project area. In addition, marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur non-auditory impairment or other physical effects. The small airgun array proposed to be used by Shell would only have 190 and 180 dB distances of 35 and 125 m (115 and 410 ft), respectively.

Therefore, it is unlikely that such effects would occur during Shell's proposed surveys given the brief duration of exposure and the planned monitoring and mitigation measures described later in this document.

(6) Stranding and Mortality

Marine mammals close to underwater detonations of high explosive can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.* 1993; Ketten 1995). Airgun pulses are less energetic and their peak amplitudes have slower rise times, while stranding and mortality events would include other energy sources (acoustical or shock wave) far beyond just seismic airguns. To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays.

However, in numerous past IHA notices for seismic surveys, commenters have referenced two stranding events allegedly associated with seismic activities, one off Baja California and a second off Brazil. NMFS has addressed this concern several times, and, without new information, does not believe that this issue warrants further discussion. For information relevant to strandings of marine mammals, readers are encouraged to review NMFS' response to comments on this matter found in 69 FR 74906 (December 14, 2004), 71 FR 43112 (July 31, 2006), 71 FR 50027 (August 24, 2006), and 71 FR 49418 (August 23, 2006). In addition, a May-June 2008, stranding of 100–200 melon-headed whales (*Peponocephala electra*) off Madagascar that appears to be associated with seismic surveys is currently under investigation (IWC 2009).

It should be noted that strandings related to sound exposure have not been recorded for marine mammal species in the Beaufort and Chukchi seas. NMFS notes that in the Beaufort Sea, aerial surveys have been conducted by MMS and industry during periods of industrial activity (and by MMS during times with no activity). No strandings or marine mammals in distress have been observed during these surveys and none have been reported by North Slope Borough inhabitants. As a result, NMFS does not expect any marine mammals will incur serious injury or mortality in the Arctic Ocean or strand as a result of proposed seismic survey.

Potential Effects From Active Sonar Equipment on Marine Mammals

Several active acoustic sources other than the 40 cu-in airgun have been proposed for Shell's 2010 open water marine surveys in the Beaufort and Chukchi Seas. The specifications of these sonar equipments (source levels and frequency ranges) are provided above. In general, the potential effects of these equipments on marine mammals are similar to those from the airgun, except the magnitude of the impacts is expected to be much less due to the lower intensity and higher frequencies. Estimated source levels and zones of influence from sonar equipment are discussed above. In some cases, due to the fact that the operating frequencies of some of this equipment (*e.g.,* Multi-beam echo sounder: frequency at 240 kHz) are above the hearing ranges of marine mammals, use of the equipment is not expected to cause any take of marine mammals.

Vessel Sounds

In addition to the noise generated from seismic airguns and active sonar systems, various types of vessels will be used in the operations, including source vessels and support 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 have been 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. Compared to airgun pulses, 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.* 1995). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice. Source levels from various vessels would be empirically measured before the start of marine surveys.

Anticipated Effects on Habitat

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

Potential Impacts on Prey Species

With regard to fish as a prey source for cetaceans and pinnipeds, 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), 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.* 1995).

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 zooplanktoners to sound are, for the most part, not known. Their abilities to move significant distances are limited or nil, depending on the type of animal. A reaction by zooplankton to sounds produced by the marine survey 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 near the airgun source, which is expected to be a very small area. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding mysticetes.

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 open water marine survey program. Anticipated take of marine mammals is associated with noise propagation from the seismic airgun(s) used in the site clearance and shallow hazards surveys.

The full suite of potential impacts to marine mammals 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 open water marine survey programs 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.* 1995). 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 open water marine survey programs do not have received levels high enough to elicit even mild TTS beyond a short distance. For instance, for the airgun sources, the 180- and 190-dB re 1 µPa (rms) isopleths extend to 125 m and 35 m from the source, respectively. None of the other active acoustic sources is expected to have received levels above 180 dB re 1 µPa (rms) within the frequency bands of marine mammal hearing sensitivity (below 180 kHz) beyond a few meters from the source. Finally, based on the proposed mitigation and monitoring measures described earlier in this document, no injury or mortality of marine mammals is anticipated as a result of Shell's proposed open water marine survey programs.

For impulse sounds, such as those produced by airgun(s) used for the site clearance and shallow hazards surveys, NMFS uses the 160 dB re 1 µPa (rms) isopleth to indicate the onset of Level B harassment. Shell provided calculations for the 160-dB isopleths produced by these active acoustic sources and then used those isopleths to estimate takes by harassment. NMFS used these calculations to make the necessary MMPA 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.

Shell has requested an authorization to take individuals of 11 marine mammal species by Level B harassment. These 11 marine mammal species are: beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), harbor porpoise (*Phocoena phocoena*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), bearded seal (*Erignathus barbatus*), ringed seal (*Phoca hispida*), spotted seal (*P. largha*), and ribbon seal (*Histriophoca fasciata*). However, NMFS believes that narwhals, minke whales, and ribbon seals are not likely to occur in the proposed survey area during the time of the proposed site clearance and shallow hazards surveys. Therefore, NMFS believes that only the other eight of the 11 marine mammal species would likely be taken by Level B behavioral harassment as a result of the proposed marine surveys.

Basis for Estimating "Take by Harassment"

As stated previously, it is current NMFS policy to estimate take by Level B harassment for impulse sounds as occurring when an animal is exposed to a received level of 160 dB re 1 µPa (rms). 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) provides 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 7, 9, and 11 in Southall *et al.* (2007) outline the numbers of low-frequency cetaceans, mid-frequency cetaceans, and pinnipeds in water, respectively, reported as having behavioral responses to multi-pulses in 10-dB received level increments. These tables illustrate that

the more severe reactions did not occur until sounds were much higher than 160 dB re 1 μPa (rms).

The proposed open water marine surveys would use low energy active acoustic sources, including a total volume of 40 cu-in airgun or airgun array. Other active acoustic sources used for ice gouging and strudel scour all have relatively low source levels and/or high frequencies beyond marine mammal hearing range. Table 1 depicts the modeled and/or measured source levels, and radii for the 120, 160, 180, and 190 dB re 1 μPa (rms) from various sources (or equivalent) that are proposed to be used in the marine mammal surveys by Shell.

Table 1. A list of active acoustic sources proposed to be used for the Shell's 2010 open water marine surveys in the Chukchi and Beaufort Seas

TABLE 1—A LIST OF ACTIVE ACOUSTIC SOURCES PROPOSED TO BE USED FOR THE SHELL'S 2010 OPEN WATER MARINE SURVEYS IN THE CHUKCHI AND BEAUFORT SEAS

Survey types	Active acoustic sources	Frequency	Modeled source level	Radii (m) at modeled received levels (dB re 1 μPa)			
				190	180	160	120
Site Clearance & Shallow Hazards.	40 cu-in airgun	.....	217	35	125	1,220	14,900
	Dual frequency side scan	190 & 240 kHz	225	Not modeled/measured because frequency outputs beyond marine mammal hearing range.			
	Single beam echo sound	100–340 kHz	180–200	Not modeled/measured because majority of frequency outputs beyond marine mammal hearing range.			
	Shallow sub-bottom profiler.	3.5 kHz (Alpha Helix)	193.8	1	3	14	310
		3.5 kHz (*Henry C.*) ...	167.2	NA	NA	3	980
		400 Hz	176.8	NA	NA	9	1,340
Ice Gouging Surveys.	Dual freq sub-bottom profiler.	2–7 kHz & 8–23 kHz	184.6	NA	2	7	456
	Multibeam Echo Sounder	240 kHz	Not modeled/measured because frequency outputs beyond marine mammal hearing range.				
Strudel Scour Survey.	Multibeam Echo Sounder	240 kHz	Not modeled/measured because frequency outputs beyond marine mammal hearing range.				
	Single Beam Bathymetric Sonar.	>200 kHz	215	Not modeled/measured because frequency outputs beyond marine mammal hearing range.			

"Take by Harassment" is calculated in this section and Shell's application by multiplying the expected densities of marine mammals that may occur in the site clearance and shallow hazards survey area by the area of water body likely to be exposed to airgun impulses with received levels of ≥160 dB re 1 μPa (rms). 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. 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. The estimated 30 days of site clearance and shallow hazards survey activity will take place in eastern Harrison Bay at approximately five potential prospective future drill sites. The survey lines form a grid or survey "patch." It is expected that three of these patches will be surveyed during the summer and two during the fall. The areas of water exposed to sounds during surveys at the patches are separated by season in this manner and as described further below.

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, 200–2,000 m), basin (≤6,562 ft, 2,000 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 site clearance and shallow hazards surveys are expected to drop below 160 dB within the nearshore zone (0–131 ft, 0–40 m, water depth). Sounds ≥160 dB are not expected to occur in waters >656 ft (200 m). Because airgun sounds at the indicated levels would not be introduced to the outer continental shelf, 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 near Harrison Bay. However, because some of the survey equipment towed behind the vessel may be damaged by ice, site clearance and shallow hazards survey activities will generally avoid sea-ice. Therefore, Shell has assumed that only 10% of the area exposed to sounds ≥160 dB by the survey will be near ice margin habitat. Ice-margin densities of marine mammals in both seasons have therefore been multiplied by 10% of the area exposed to sounds by the airguns, while open-water (nearshore) densities have been multiplied by the remaining 90% of the area (*see* area calculations below).

To provide some allowance for the uncertainties, Shell calculated both "maximum estimates" as well as "average estimates" of the numbers of marine mammals that could potentially be affected. 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. For several species whose average densities are too low to yield a take number due to extra-limital distribution in the vicinity of the proposed Beaufort Sea survey area, but whose chance occurrence has been documented in the past, such as gray and humpback whales and harbor porpoises, NMFS allotted a few numbers of these species to allow unexpected takes of these species.

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% 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.* 2000b).

(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 of bowhead whales, some of which are in feeding aggregations, are found in the eastern Alaskan Beaufort Sea and the northeastern Chukchi Sea. Belugas begin to move across the Alaskan Beaufort Sea in August, and the majority of 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 was based on 11,985 km (7,749 mi) of on-transect effort and 9 associated sightings that occurred in water ≤50 m (164 ft) in Moore *et al.* (2000; Table 2). 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 2). The fall beluga whale nearshore density was based on 72,711 km (45,190 mi) of on-transect effort and 28 associated sightings that occurred in water ≤50 m (164 ft) 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 ≤50 m (164 ft) of water present in the MMS Bowhead Whale Aerial Survey Program (BWASP) 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 (below) because of the relatively lower expected densities of beluga whales in nearshore habitat near the site clearance and shallow hazards surveys and the lack of detailed data on the likely timing and rate of migration through the area (Table 3).

TABLE 2—EXPECTED SUMMER (JUL–AUG) DENSITIES OF BELUGA AND BOWHEAD WHALES IN THE ALASKAN BEAUFORT SEA. DENSITIES ARE CORRECTED FOR F(0) AND G(0) BIASES

	Nearshore	Ice margin
Species	Average Density (#/km^2).	Average Density (#/km^2).
Beluga whale	0.0030.	0.0030.
Bowhead whale	0.0186.	0.0186.

TABLE 3—EXPECTED FALL (SEP–NOV) DENSITIES OF BELUGA AND BOWHEAD WHALES IN THE ALASKAN BEAUFORT SEA. DENSITIES ARE CORRECTED FOR F(0) AND G(0) BIASES

	Nearshore	Ice margin
Species	Average Density (#/km^2).	Average Density (#/km^2).
Beluga whale	0.0027.	0.0054.
Bowhead whale*	N/A.	N/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/km^2, respectively. The estimate of 0.0186 whales/km^2 was used as the average nearshore density, and the estimate of 0.0717 whales/km^2 was used as the maximum (Table 2). 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 site clearance and shallow hazards surveys, 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 has developed an alternate method of calculating the number of individuals exposed to sounds produced by the site clearance and shallow hazards surveys. The method is founded on estimates of the proportion of the population that would pass within the ≥160 dB rms zones on a given day in the fall during survey activities.

Approximately 10 days of site clearance and shallow hazards survey activity are likely to occur during the fall period when bowheads are migrating through the Beaufort Sea. If the bowhead population has continued to grow at an annual rate of 3.4%, the current population size would be approximately 14,247 individuals based on a 2001 population of 10,545 (Zeh and Punt 2005). Based on data in Richardson and Thomson (2002, Appendix 9.1), the number of whales expected to pass each day 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 (<20 m, 20–40 m, 40–200 m, >200 m; or <65 ft, 65–131 ft, 131–656 ft, >656 ft). Using this information the total number of whales expected to pass the site clearance and shallow hazards surveys each day was multiplied 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 ≥160 dB rms 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 10 days (September 15–19 and October 1–4) and the results were summed to estimate the total number of bowhead whales that might be exposed to ≥160 dB rms during the migration period in the Beaufort Sea.

Other Cetaceans—For other cetacean species that may be encountered in the Beaufort Sea, 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. Harbor porpoises and 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 (Table 4). Narwhals are not expected to be encountered during the site clearance and shallow hazards surveys. However, there is a chance that a few individuals may be present if ice is nearby. The first record of humpback whales in the Beaufort Sea was documented in 2007 so their presence cannot be ruled out. Since these species occur so infrequently in the Beaufort Sea, little to no data are available for the calculation of densities. Minimal densities have therefore been assigned for calculation purposes and to allow for chance encounters (Table 4).

TABLE 4. EXPECTED DENSITIES OF CETACEANS (EXCLUDING BELUGA AND BOWHEAD WHALE) AND SEALS IN THE ALASKAN BEAUFORT SEA

	Nearshore	Ice margin
Species	Average density (#/km^2)	Average density (#/km^2)
Narwhal	0.0000	0.0000
Harbor porpoise	0.0001	0.0000
Gray whale	0.0001	0.0000
Bearded seal	0.0181	0.0128
Ribbon seal	0.0001	0.0001
Ringed seal	0.3547	0.2510
Spotted seal	0.0037	0.0001

(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 4 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 4 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 4 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 4 here). Minimal values were assigned as densities in the ice-margin zones (Table 6–3 in Shell's application and Table 4 here).

Potential Number of Takes by Harassment

Numbers of marine mammals that might be present and potentially disturbed are estimated below based on available data about mammal distribution and densities at different locations and times of the year as described previously. The planned site clearance and shallow hazards survey would take place in the Beaufort Sea over two different seasons. The estimates of marine mammal densities have therefore been separated both spatially and temporarily in an attempt to represent the distribution of animals expected to be encountered over the duration of the site clearance and shallow hazards survey.

The number of individuals of each species potentially exposed to received levels ≥160 dB re 1 μPa (rms) within each season and habitat zone was estimated by multiplying

- the anticipated area to be ensonified to the specified level in each season and habitat zone to which that density applies, by
- the expected species density.

The numbers of potential individuals exposed were then summed for each species across the two seasons and habitat zones. Some of the animals estimated to be exposed, particularly migrating bowhead whales, might show avoidance reactions before being exposed to ≥160 dB re 1 μPa (rms). Thus, these calculations actually estimate the number of individuals potentially exposed to ≥160 dB that would occur if there were no avoidance of the area ensonified to that level.

The area of water potentially exposed to received levels ≥160 dB re 1 μPa (rms) by airgun operations was calculated by buffering a typical site clearance and shallow hazards survey grid of lines by the estimated >160 dB distance from the airgun source, including turns between lines during which a single mitigation airgun will be active. Measurements of a 2 x 10 in^3 airgun array used in 2007 were reported by Funk *et al.* (2008). These measurements were used to model both of the potential airgun arrays that may be used in 2010, a 4 x 10 in^3 array or a 2 x 10 in^3 + 1 x 20 in^3 array. The modeling results showed that the 40 cubic inch array is likely to produce sound that propagates further than the alternative array, so those results were used. The modeled 160 dB re 1 μPa (rms) distance from a 40 cubic inch array was 1,220 m (4,003 ft) from the source. Because this is a modeled estimate, but based on similar measurements at the same location, the estimated distance was only increased by a factor of 1.25 instead of a typical 1.5 factor. This results in a 160 dB distance of 1,525 m (5,003 ft) which was added to both sides of the survey lines in a typical site clearance and shallow hazards survey grid. The resulting area that may be exposed to airgun sounds ≥160 dB re 1 μPa (rms) is 81.6 km^2. In most cases the use of a single mitigation gun during turns will not appreciably increase the total area exposed to sounds ≥160 dB re 1 μPa (rms), but analysis of a similar survey pattern from the Chukchi Sea (but using the Beaufort sound radii) suggested use of the mitigation gun may increase this area to 82.3 km^2. As described above, three patches (246.9 km^2) are likely to be surveyed during the summer leaving two (164.6 km^2) for the fall. During both seasons, 90% of the area has been multiplied by nearshore (open-water) densities, and the remaining 10% by the ice-margin densities.

For analysis of potential effects on migrating bowhead whales we calculated the maximum distance perpendicular to the migration path ensonified to ≥160 dB re 1 μPa (rms) by a typical survey patch as 11.6 km (7.2 mi). This distance represents approximately 21% of the 56 km (34.8 mi) between the barrier islands and the 40-m (131-ft) bathymetry line so it was assumed that 21% of the bowheads migrating within the nearshore zone (water depth 0–40 m, or 0–131 ft) may be exposed to sounds ≥160 dB re 1 μPa (rms) if they showed no avoidance of the site clearance and shallow hazards survey activities.

Cetaceans—Cetacean species potentially exposed to airgun sounds with received levels ≥160 dB re 1 μPa (rms) would involve bowhead, gray, humpback, and beluga whales and harbor porpoises. Shell also included some maximum exposure estimates for narwhal and minke whale. However, as stated previously in this document, NMFS has determined that authorizing take of these two cetacean species is not warranted given the highly unlikely potential of these species to occur in the open water marine survey area. The average estimates of the number of individual bowhead whales exposed to received sound levels ≥160 dB re 1 μPa (rms) is 381 and belugas is 1 individual. However, since beluga whales often form small groups, it is likely that the exposure to the animals would be based on groups instead of individual animals. Therefore, NMFS proposes to make an adjustment to increase the number of beluga whale takes to 5 individuals to reflect the aggregate nature of these animals.

The estimates show that one endangered cetacean species (the bowhead whale) is expected to be exposed to sounds ≥160 dB re 1 μPa (rms) unless bowheads avoid the area around the site clearance and shallow hazards survey areas (Tables 4). 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.

As discussed before, although no take estimates of gray and humpback whales and harbor porpoises can be calculated due to their low density and extralimital distribution in the vicinity of the site clearance and shallow hazards survey area in the Beaufort Sea, their occurrence has been documented in the past. Therefore, to allow for chance encounters of these species, NMFS proposes to include two individuals of each of these three species as having the potential to be exposed to an area with received levels ≥160 dB re 1 μPa (rms).

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 site clearance and shallow hazard survey activities, and hence exposed to sounds with received levels ≥160 dB re 1 μPa (rms). The average estimate is that 567 ringed seals might be exposed to sounds with received levels ≥160 dB re 1 μPa (rms) from airgun impulses.

Two additional seal species are expected to be encountered. Average estimates for bearded seal exposures to sound levels ≥160 dB re 1μPa (rms) is 7 individuals. For spotted seal the exposure estimates is 1 individual.

Table 5 summarizes the number of potential takes by harassment of all species.

TABLE 5—SUMMARY OF THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥160 dB DURING SHELL'S PLANNED SITE CLEARANCE AND SHALLOW HAZARDS SURVEYS NEAR HARRISON BAY IN THE BEAUFORT SEA, ALASKA, JULY—OCTOBER, 2010

Species	Total number of exposure to sound levels >160 dB re 1 μPa (rms)
Beluga whale	5
Harbor porpoise	2
Bowhead whale	381
Gray whale	2
Humpback whale	2
Bearded seal	7
Ringed seal	142
Spotted seal	1

Estimated Take Conclusions

Cetaceans—Effects on cetaceans are generally expected to be restricted to avoidance of an area around the site clearance and shallow hazards surveys and short-term changes in behavior, falling within the MMPA definition of "Level B harassment".

Using the 160 dB criterion, the average estimates of the numbers of individual cetaceans exposed to sounds ≥160 dB re 1 μPa (rms) represent varying proportions of the populations of each species in the Beaufort Sea and adjacent waters. For species listed as "Endangered" under the ESA, the estimates include approximately 381 bowheads. This number is approximately 2.7% of the Bering-Chukchi-Beaufort population of >14,247 assuming 3.4% annual population growth from the 2001 estimate of >10,545 animals (Zeh and Punt 2005). The small numbers of other mysticete whales that may occur in the Beaufort Sea are unlikely to occur near the planned site clearance and shallow hazards surveys. The few that might occur would represent a very small proportion of their respective populations. The average estimate of the number of belugas that might be exposed to ≥160 dB re 1 μPa (rms) (1, with adjustment to 5 considering group occurrence) represents <1% of its population.

Seals—A few seal species are likely to be encountered in the study area, but ringed seal is by far the most abundant in this area. The average estimates of the numbers of individuals exposed to sounds at received levels ≥160 dB re 1 μPa (rms) during the site clearance and shallow hazards surveys are as follows: ringed seals (142), bearded seals (7), and spotted seals (1), (representing <1% of their respective Beaufort Sea populations).

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

Relevant Subsistence Uses

The disturbance and potential displacement of marine mammals by sounds from the proposed marine surveys 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. (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 and Chukchi Seas that have the potential to be impacted by Shell's proposed open water marine surveys include Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Lay. Kaktovik is a coastal community near the east boundary of the proposed ice gouging area. Nuiqsut is approximately 30 mi (50 km) inland from the proposed site clearance and shallow hazards survey area. Cross Island, from which Nuiqsut hunters base their bowhead whaling activities, is approximately 44 mi (70 km) east of the proposed site clearance and shallow hazards survey area. Barrow lies approximately 168 mi (270 km) west of Shell's Harrison Bay site clearance and shallow hazards survey areas. Wainwright is a coastal community approximately 12 mi (20 km) to the southeast boundary of the proposed ice gouging survey area in the Chukchi Sea. Point Lay is another coastal community boarding the southwest boundary of the proposed ice gouging survey area in the Chukchi Sea. Point Hope is the western tip of the North Slope and is approximately 124 mi (200 km) southwest of Shell's proposed ice gouge survey area in the Chukchi Sea.

(1) Bowhead Whales

Of the three communities along the Beaufort Sea coast, 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 marine surveys in Beaufort Sea will not begin until July 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 point 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 hunt 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.

Along the Chukchi Sea, the spring bowhead whale hunt for Wainwright occurs between April and June in leads offshore from the village. Whaling camps can be located up to 16–24 km (10–15 mi) from shore, depending on where the leads open up. Whalers prefer to be closer, however, and will sometimes go overland north of Wainwright to find closer leads (SRBA 1993). Residents of Point Lay have not hunted bowhead whales in the recent past, but were selected by the International Whaling Commission (IWC) to receive a bowhead whale quota in 2009, and began bowhead hunting again in 2009. In the more distant past, Point Lay hunters traveled to Barrow, Wainwright, or Point Hope to participate in the bowhead whale harvest activities. In Point Hope, the bowhead whale hunt occurs between March and June, when the pack-ice lead is usually 10–11 km (6–7 mi) offshore. Camps are set up along the landfast ice edge to the south and southeast of the village. Point Hope whalers took between one and seven bowhead whales per year between 1978 and 2008, with the exception of 1980, 1989, 2002, and 2006, when no whales were taken (Suydam and George 2004; Suydam *et al.* 2008, 2007, 2006, 2005). There is no fall bowhead hunt in Point Hope, as the whales migrate back down on the west side of the Bering Strait, out of range of the Point Hope whalers (Fuller and George 1997).

(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.

In the Chukchi communities, the spring beluga hunt by Wainwright residents is concurrent with the bowhead hunt, but belugas are typically taken only during the spring hunt if bowheads are not present in the area. Belugas are also hunted later in the summer, between July and August, along the coastal lagoon systems. Belugas are usually taken less than 16 km (10 mi) from shore. Beluga whales are harvested in June and July by Point Lay residents. They are taken in the highest numbers in Naokak and Kukpowruk Passes south of Point Lay, but hunters will travel north to Utukok Pass and south to Cape Beaufort in search of belugas. The whales are usually herded by hunters with their boats into the shallow waters of Kasegaluk Lagoon (MMS 2007). In Point Hope, belugas are also hunted in the spring, coincident with the spring bowhead hunt. A second hunt takes place later in the summer, in July and August, and can extend into September, depending on conditions and the IWC quota. The summer hunt is conducted in open water along the coastline on either side of Point Hope, as far north as Cape Dyer (MMS 2007). Belugas are smaller than bowhead whales, but beluga whales often make up a significant portion of the total harvest for Point Hope (Fuller and George 1997; SRBA 1993). Ninety-eight belugas harvested in 1992 made up 40.3% of the total edible harvest for that year. Three bowhead whales represented 6.9% of the total edible harvest for the same year (Fuller and George 1997).

(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 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 drains into Harrison Bay, where Shell's proposed site clearance and shallow hazards surveys are planned.

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 marine surveys, the primary sealing months occur outside of Shell's operating time frame.

In the Chukchi Sea, seals are most often taken between May and September by Wainwright residents. Wainwright hunters will travel as far south as Kuchaurak Creek (south of Point Lay) and north to Peard Bay. Hunters typically stay within 72 km (45 mi) of the shore. Ringed and bearded seals are harvested all year by Point Lay hunters. Ringed seals are hunted 32 km (20 mi) north of Point Lay, as far as 40 km (25 mi) offshore. Hunters travel up to 48 m (30 mi) north of the community for bearded seals, which are concentrated in the Solivik Island area. Bearded seals are also taken south of the community in Kasegaluk Lagoon, and as far as 40 km (25 mi) from shore. Seals are harvested throughout most of the year by the Point Hope community, although they tend to be taken in the greatest numbers in the winter and spring months. The exception is the bearded seal hunt, which peaks later in the spring and into the summer (Fuller and George 1997; MMS 2007). Species of seals harvested by Point Hope hunters include ringed, spotted, and bearded. Seals are hunted on the ice (Fuller and George 1997). Hunters tend to stay close to the shore but will travel up to 24 km (15 mi) offshore south of the point, weather dependent. Seals are hunted to the north of the community as well, but less often, as the ice is less stable and can be dangerous. Seals are taken between Akoviknak Lagoon to the south and Ayugatak Lagoon to the north (MMS 2007).

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 open water marine surveys 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. 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 and Chukchi Seas, 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 or Plan)

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's POC is also subject to MMS Lease Sale Stipulation No. 5, which requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and the subsistence activities and resources of residents of the North Slope.

The POC identifies the measures that Shell has developed in consultation with North Slope subsistence communities and will implement during its planned 2010 site clearance and shallow hazards surveys and ice gouge surveys to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell's communications and consultations with local subsistence communities concerning its planned 2010 program, potential conflicts with subsistence activities, and means of resolving any such conflicts. Shell states that through its Subsistence Advisor (SA) and Com and Call Center (Com Center) program for 2010, Shell's SA and Shell representatives in the Com Centers will be available daily to the communities throughout the 2010 season. The SA and Com Center programs provide residents of the nearest affected communities a way to communicate where and when subsistence activities so that industry may avoid conflicts with planned subsistence activities. Shell continues to document its contacts with the North Slope subsistence communities, as well as the substance of its communications with subsistence stakeholder groups.

Shell states that the POC will be, and has been in the past, the result of numerous meetings and consultations between Shell, affected subsistence communities and stakeholders, and federal agencies. The POC identifies and documents potential conflicts and associated measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence use. Outcomes of POC meetings are attached to the POC as addenda and were distributed to Federal, State, and local agencies as well as local stakeholder groups that either adjudicate or influence mitigation approaches for Shell's open water programs.

Meetings for Shell's 2010 program in the Beaufort and Chukchi Seas were conducted for Nuiqsut, Kaktovik, Barrow, Point Hope, Point Lay, Wainwright, and Kotzebue in the 1st quarter of 2010. Shell met with the marine mammal commissions and committees including the Alaska Eskimo Whaling Commission, Eskimo Walrus Commission, Alaska Beluga Whale Committee, Alaska Ice Seal Committee, and the Alaska Nanuuq Commission on December 8, 2009 in co-management meeting. Throughout 2010 Shell anticipates continued engagement with the marine mammal commissions and committees active in the subsistence harvests and marine mammal research.

Following the 2010 season, Shell intends to have a post-season co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

Mitigation Measures

In order to issue an incidental take authorization under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse 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.

For Shell's proposed open water marine surveys in the Beaufort and Chukchi Sea, Shell worked with NMFS and proposed the following mitigation measures to minimize the potential impacts to marine mammals in the project vicinity as a result of the marine survey activities.

As part of the application, Shell submitted to NMFS a Marine Mammal Monitoring and Mitigation Program (4MP) for its shallow hazards survey activities in the Beaufort Sea during the 2010 open-water season. The objectives of the 4MP are:

- To ensure that disturbance to marine mammals and subsistence hunts is minimized and all permit stipulations are followed,
- To document the effects of the proposed survey activities on marine mammals, and
- To collect baseline data on the occurrence and distribution of marine mammals in the study area.

For the proposed Shell's 2010 open water marine survey program in the Beaufort and Chukchi Seas, the following mitigation measures are required.

(1) Sound Source Measurements

As described above, previous measurements of airguns in the Harrison Bay area were used to model the distances at which received levels are likely to fall below 160, 180, and 190 dB re 1 μPa (rms) from the planned airgun sources. These modeled distances will be used as temporary safety radii until measurements of the airgun sound source are conducted. The measurements will be made at the beginning of the field season and the measured radii used for the remainder of the survey period.

The objectives of the sound source verification measurements planned for 2010 in the Beaufort Sea will be to measure the distances in the broadside and endfire directions at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 μPa (rms) for the energy source array combinations that may be used during the survey activities. The configurations will include at least the full array and the operation of a single source that will be used during power downs. The measurements of energy source array sounds will be made at the beginning of the survey and the distances to the various radii will be reported as soon as possible after recovery of the equipment. The primary radii of concern will be the 190 and 180 dB safety radii for pinnipeds and cetaceans, respectively, and the 160 dB disturbance radii. In addition to

reporting the radii of specific regulatory concern, nominal distances to other sound isopleths down to 120 dB re 1 μPa (rms) will be reported in increments of 10 dB.

Data will be previewed in the field immediately after download from the ocean bottom hydrophone (OBH) instruments. An initial sound source analysis will be supplied to NMFS and the airgun operators within 120 hours of completion of the measurements, if possible. The report will indicate the distances to sound levels between 190 dB re 1 μPa (rms) and 120 dB re 1 μPa (rms) based on fits of empirical transmission loss formulae to data in the endfire and broadside directions. The 120-hour report findings will be based on analysis of measurements from at least three of the OBH systems. A more detailed report including analysis of data from all OBH systems will be issued to NMFS as part of the 90-day report following completion of the acoustic program.

Airgun pressure waveform data from the OBH systems will be analyzed using JASCO's suite of custom signal processing software that implements the following data processing steps:

- Energy source pulses in the OBH recordings are identified using an automated detection algorithm. The algorithm also chooses the 90% energy time window for rms sound level computations.
- Waveform data is converted to units of μPa using the calibrated acoustic response of the OBH system. Gains for frequency-dependent hydrophone sensitivity, amplifier and digitizer are applied in this step.
- For each pulse, the distance to the airgun array is computed from GPS deployment positions of the OBH systems and the time referenced DGPS navigation logs of the survey vessel.
- The waveform data are processed to determine flat-weighted peak sound pressure level (PSPL), rms SPL and SEL.
- Each energy pulse is Fast Fourier Transformed (FFT) to obtain 1-Hz spectral power levels in 1-second steps.
- The spectral power levels are integrated in standard 1/3-octave bands to obtain band sound pressure levels (BSPL) for bands from 10 Hz to 20 kHz. Both un-weighted and M-weighted (frequency weighting based on hearing sensitivities of four marine mammal functional hearing groups, *see* Southall *et al.* (2007) for a review) SPL's for each airgun pulse may be computed in this step for species of interest.

The output of the above data processing steps includes listings and graphs of airgun array narrow band and broadband sound levels versus range, and spectrograms of shot waveforms at specified ranges. Of particular importance are the graphs of level versus range that are used to compute representative radii to specific sound level thresholds.

Power density spectra (frequency spectra) of high frequency active acoustic sources (operating frequency >180 kHz) that will be used in Shell's marine surveys will also be measured against ambient background noise levels and reported in 1/3-octave band and 1-Hz band from 10 Hz to 180 kHz. The purpose for this measurement is to determine whether there is any acoustic energy within marine mammal hearing ranges that would be generated from operating these high frequency acoustic sources.

(2) Safety and Disturbance Zones

Under current NMFS guidelines, "safety radii" for marine mammal exposure to impulse sources are customarily defined as the distances within which received sound levels are ≥180 dB re 1 μPa (rms) for cetaceans and ≥190 dB re 1 μPa (rms) for pinnipeds. These safety criteria are based on an assumption that SPL received at levels lower than these will not injure these animals or impair their hearing abilities, but that SPL received at higher levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson *et al.* 1995).

Initial safety and disturbance radii for the sound levels produced by the survey activities have been modeled. These radii will be used for mitigation purposes until results of direct measurements are available early during the exploration activities. The planned survey will use an airgun source composed of either 40 in^3 airguns or 1 × 20-in^3 plus 2 × 10-in^3 airguns. The total source volume will be 4 × 10 in^3. Measurements of a 2 × 10-in^3 airgun array used in 2007 were reported by Funk *et al.* (2008). These measurements were used as the basis for modeling both of the potential airgun arrays that may be used in 2010. The modeling results showed that the 40 in^3 array is likely to produce sounds that propagate further than the alternative array, so those results were used to estimate "takes by harassment" in Shell's IHA application and will also be used during initial survey activities prior to in-field sound source measurements. The modeled 190 and 180 dB distances from a 40 cubic inch array were 35 and 125 m, respectively. Because this is a modeled estimate, but based on similar measurements at the same location, the estimated distances for initial safety radii were only increased by a factor of 1.25 instead of a typical 1.5 factor. This results in a 190-dB distance of 44 m and a 180-dB distance of 156 m.

A single 10-in^3 airgun will be used as a mitigation gun during turns or if a power down of the full array is necessary due to the presence of a marine mammal close to the vessel. Underwater sound propagation of a 10-in^3 airgun was measured near Harrison Bay in 2007 and results were reported in Funk *et al.* (2008). The 190 dB and 180 dB distances from those measurements, 5 m and 20 m respectively, will be used as the pre-sound source measurement safety zones during use of the single mitigation gun.

An acoustics contractor will perform the direct measurements of the received levels of underwater sound versus distance and direction from the energy source arrays using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the safety distances. The mitigation measures to be implemented at the 190 and 180 dB sound levels will include power downs and shut downs as described below.

(3) Power Downs and Shut Downs

A power-down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shutdown is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full arrays but is outside or about to enter the applicable safety zone of the single mitigation source. If a marine mammal is sighted within the applicable safety zone of the single mitigation airgun, the entire array will be shut down (*i.e.,* no sources firing). Although MMOs will be located on the bridge ahead of the center of the airgun array, the shutdown criterion for animals ahead of the vessel will be based on the distance from the bridge (vantage point for MMOs) rather than from the airgun array—a precautionary approach. For marine mammals sighted alongside or behind the airgun array, the distance is measured from the array.

Following a power-down or shutdown, operation of the airgun array will not resume until the marine mammal has cleared the applicable safety zone. The animal will be considered to have cleared the safety zone if it:

• Is visually observed to have left the safety zone;
• Has not been seen within the zone for 15 min in the case of small odontocetes and pinnipeds; or
• Has not been seen within the zone for 30 min in the case of mysticetes.

In the unanticipated event that an injured or dead marine mammal is sighted within an area where Shell deployed and utilized seismic airguns within the past 24 hours, Shell will immediately shutdown the seismic airgun array and notify the Marine Mammal Stranding Network within 24 hours of the sighting.

In the event that the marine mammal has been determined to have been deceased for at least 72 hours, as certified by the lead MMO onboard the source vessel, and no other marine mammals have been reported injured or dead during that same 72 hour period, the airgun array may be restarted (by conducting the necessary ramp-up procedures described elsewhere in this section of the document) upon completion of a written certification by the MMO. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). Within 24 hours after the event specified herein, Shell must notify NMFS by telephone or email of the event and ensure that the written certification is provided to NMFS.

In the event that the marine mammal injury resulted from something other than seismic airgun operations (*e.g.,* gunshot wound, polar bear attack), as certified by the lead MMO onboard the seismic vessel, the airgun array may be restarted (by conducting the necessary ramp-up procedures described elsewhere in this section of the document) upon completion of a written certification by the MMO. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). Within 24 hours after the event specified herein, Shell must notify NMFS by telephone or email of the event and ensure that the written certification is provided to NMFS.

In the event the animal has not been dead for a period greater than 72 hours or the cause of the injury or death cannot be immediately determined by the lead MMO, Shell shall immediately report the incident to either the NMFS staff person designated by the Director, Office of Protected Resources or to the staff person designated by the Alaska Regional Administrator. The lead MMO must complete written certification and provide it to the NMFS staff person. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). The airgun array may be restarted (by conducting the necessary ramp-up procedures described elsewhere in this section of the document) upon completion of the written certification.

In the event that the marine mammal death or injury was directly caused by the seismic airgun operations (*e.g.,* struck by a vessel, entangled in gear), Shell shall immediately report the incident to the designated NMFS staff person by telephone or email and the Marine Mammal Stranding Network of the event and ensure that written certification is provided to the NMFS staff person. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). The airguns may not be restarted until NMFS has had an opportunity to review the written certification and any accompanying documentation, make determinations as to whether modifications to the activities are appropriate and necessary, and has notified Shell that activities may be resumed. Approval to resume operations may be provided via letter, e-mail, or telephone.

(4) Ramp Ups

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a stepwise increase in the number and total volume of airguns firing until the full volume is achieved.

The purpose of a ramp up (or "soft start") is to "warn" cetaceans and pinnipeds in the vicinity of the airguns and to provide time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed shallow hazards survey program, the seismic operator will ramp up the airgun arrays slowly. Full ramp ups (*i.e.,* from a cold start after a shut down, when no airguns have been firing) will begin by firing a single airgun in the array. The minimum duration of a shut-down period, *i.e.,* without air guns firing, which must be followed by a ramp up typically is the amount of time it would take the source vessel to cover the 180-dB safety radius. The actual time period depends on ship speed and the size of the 180-dB safety radius. That period is estimated to be about 1–2 minutes based on the modeling results described above and a survey speed of 4 knots.

A full ramp up, after a shut down, will not begin until there has been a minimum of 30 min of observation of the safety zone by MMOs to assure that no marine mammals are present. The entire safety zone must be visible during the 30-minute lead-in to a full ramp up. If the entire safety zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15–30 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

During turns and transit between seismic transects, at least one airgun will remain operational. The ramp-up procedure still will be followed when increasing the source levels from one airgun to the full arrays. However, keeping one airgun firing will avoid the prohibition of a cold start during darkness or other periods of poor visibility. Through use of this approach, seismic operations can resume upon entry to a new transect without a full ramp up and the associated 30-minute lead-in observations. MMOs will be on duty whenever the airguns are firing during daylight, and during the 30-min periods prior to ramp-ups as well as during ramp-ups. Daylight will occur for 24 h/day until mid-August, so until that date MMOs will automatically be observing during the 30-minute period preceding a ramp up. Later in the season, MMOs will be called out at night to observe prior to and during any ramp up. The seismic operator and MMOs will maintain records of the times when ramp-ups start, and when the airgun arrays reach full power.

To help evaluate the utility and effectiveness of ramp-up procedures, MMOs are required to record and report their observations during any ramp-up period.

(5) Mitigation Measures Concerning Bowhead Cow/Calf Pairs and Whale Aggregations

For seismic activities (including shallow hazards and site clearance and

other marine surveys where active acoustic sources will be employed) in the Beaufort Sea after August 25, a 120-dB monitoring (safety) zone for bowhead whales will be established and monitored for the next 24 hours if four or more bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program within the area where an ensonified 120-dB zone around the vessel's track is projected. To the extent practicable, such monitoring should focus on areas upstream (eastward) of the bowhead migration. No seismic surveying shall occur within the 120-dB safety zone around the area where these whale cow-calf pairs were observed, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.

A 160-dB vessel monitoring zone for bowhead and gray whales will be established and monitored in the Chukchi Sea and after August 25 in the Beaufort Sea during all seismic surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a nonmigratory, significant biological behavior (*e.g.,* feeding, socializing)) are observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity, the seismic operation will not commence or will shut down, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 160-dB safety zone of seismic-surveying operations.

Survey information, especially information about bowhead whale cow-calf pairs or feeding bowhead or gray whale aggregations, shall be provided to NMFS as required in MMPA authorizations, and will form the basis for NMFS determining whether additional mitigation measures, if any, will be required over a given time period.

(6) Mitigation Measures Concerning Vessel Speed and Directions

Furthermore, the following measures concerning vessel speed and directions are required for Shell's 2010 open water marine survey program in the Beaufort and Chukchi Seas:

- All vessels should reduce speed to below 10 knots when within 300 yards (274 m) of whales, and 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;
- Avoid multiple changes in direction and speed when within 300 yards (274 m) of whales; and
- When weather conditions require, such as when visibility drops, support vessels must adjust speed accordingly to avoid the likelihood of injury to whales.

(7) Subsistence Mitigation Measures

The following mitigation measures, plans, and programs shall be implemented to reduce impacts from Shell's marine surveys that could potentially affect subsistence groups and communities. These measures, plans, and programs have been effective in past seasons of work in the Arctic and were developed in past consultations with these communities. These measures, plans, and programs will be implemented by Shell during its 2010 program in both the Beaufort and Chukchi Seas to monitor and mitigate potential impacts to subsistence users and resources.

Shell states that it 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 any subsistence hunts:

- For the purposes of reducing or eliminating conflicts between subsistence whaling activities and Shell's survey program, Shell will participate with other operators in the Communication and Call Centers (Com-Center) Program. The Com-Centers will be operated 24 hours/day during the 2010 fall subsistence bowhead whale hunt.
- To minimize impacts on marine mammals and subsistence hunting activities, the source vessel will transit through the Chukchi Sea along a route that lies offshore of the polynya zone. This entry into the Chukchi Sea will not occur before July 1, 2010. In the event the transit outside of the polynya zone results in Shell having to move away from ice, the source vessel may enter into the polynya zone. 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 Com-Centers.
- Shell has developed a Communication Plan and will implement the plan before initiating the 2010 program 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-Centers to be located in coastal villages along the Beaufort and Chukchi Seas during Shell's program in 2010.
- 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 may be up to nine subsistence advisor-liaison positions (one per village), to work approximately 8 hours per day and 40-hour weeks through Shell's 2010 program. 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 program activities. 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.
- Shell will also implement flight restrictions prohibiting aircraft from flying within 1,000 ft (300 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.
- Upon notification by a Com-Center operator of an at-sea emergency, Shell will provide such assistance as necessary to prevent the loss of life, if conditions allow the holder of this Authorization to safely do so.
- Upon request for emergency assistance made by a subsistence whale hunting organization, or by a member of such an organization, in order to prevent the loss of a whale, the holder of this Authorization shall assist towing of a whale taken in a traditional subsistence whale hunt, if conditions allow Shell to safely do so.
- *Post-season Review:* Following completion of the 2010 Beaufort and Chukchi Seas open water marine survey program, Shell will conduct a co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

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 evaluations and analyses of the aforementioned mitigation measures, NMFS has determined that the 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, and will have no unmitigable impact to subsistence hunt.

Monitoring and Reporting Measures

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

The following monitoring measures are required for Shell's 2010 open water marine survey program in the Beaufort and Chukchi Seas.

(1) Vessel-based MMOs

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of marine survey activities. MMOs will monitor the occurrence and behavior of marine mammals near the survey vessel during all daylight periods during operation and during most daylight periods when airgun operations are not occurring. MMO duties will include watching for and identifying marine mammals, recording their numbers, distances, and reactions to the survey operations, and documenting "take by harassment" as defined by NMFS.

A sufficient number of MMOs will be required onboard the survey vessel to meet the following criteria: (1) 100% monitoring coverage during all periods of survey 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.

MMO teams will consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the MMO team onboard the survey vessel. New observers shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations. The total number of MMOs may decrease later in the season as the duration of daylight decreases.

Shell anticipates that there will be provision for crew rotation at least every six to eight weeks to avoid observer fatigue. During crew rotations detailed hand-over notes will be provided to the incoming crew leader by the outgoing leader. Other communications such as email, fax, and/or phone communication between the current and oncoming crew leaders during each rotation will also occur when possible. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

Crew leaders and most other biologists serving as observers in 2010 will be individuals with experience as observers during one or more of the 1996–2009 seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring and mitigation projects. Resumes for those individuals will be provided to NMFS for review and acceptance of 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 marine mammal observers' handbook, adapted for the specifics of the planned survey program, will be prepared and distributed beforehand to all MMOs.

Most observers, including Inupiat observers, will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2010 open-water season. Any exceptions will have or receive equivalent experience or training. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs. Observers should be trained using visual aids (*e.g.,* videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

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

Primary objectives of the training include:

- Review of the marine mammal monitoring plan for this project, including any amendments specified by NMFS in the IHA (if issued), by USFWS and by MMS, or by other agreements in which Shell may elect to participate;
- Review of marine mammal sighting, identification, and distance estimation methods;
- Review of operation of specialized equipment (reticle binoculars, night vision devices, and GPS system);
- Review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on marine mammal sightings, monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers; and
- Review of the specific tasks of the Inupiat Communicator.

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

MMOs will watch for marine mammals from the best available vantage point on the survey vessel, typically the bridge. MMOs will scan systematically with the unaided eye and

7 × 50 reticle binoculars, supplemented with 20 × 60 image-stabilized Zeiss Binoculars or Fujinon 25 × 150 "Big-eye" binoculars and night-vision equipment when needed. With two or three observers on watch, the use of big eyes should be paired with searching by naked eye, the latter allowing visual coverage of nearby areas to detect marine mammals. Personnel on the bridge will assist the MMOs in watching for marine mammals.

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

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

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;

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

(D) Whether adjustments were made to Shell's activity status.

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 × 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 1,968 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% when given immediate feedback about actual distances during training.

For monitoring related to deployment of the AUV, MMOs will advise the vehicle operators prior to deployment if aggregations of marine mammals have been observed in the survey area which might increase the likelihood of the vehicle encountering an animal or otherwise disturbing a group of animals.

Shell plans to conduct the site clearance and shallow hazards survey 24 hr/day. Regarding nighttime operations, note that there will be no periods of total darkness until mid-August. When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, night-vision equipment ("Generation 3" binocular image intensifiers, or equivalent units) will be available for use.

(2) Aerial Survey Program

Shell proposes to conduct an aerial survey program in support of the shallow hazards program in the Beaufort Sea during the fall of 2010. The shallow hazards survey program may start in the Beaufort Sea as early as July 2010, however, aerial surveys would not begin until the start of the bowhead whale migration, around August 20, 2010. The objectives of the aerial survey will be:

- To advise operating vessels as to the presence of marine mammals (primarily cetaceans) in the general area of operation;
- To collect and report data on the distribution, numbers, movement and behavior of marine mammals near the survey operations with special emphasis on migrating bowhead whales;
- To support regulatory reporting related to the estimation of impacts of survey operations on marine mammals;
- To investigate potential deflection of bowhead whales during migration by documenting how far east of survey operations a deflection may occur and where whales return to normal migration patterns west of the operations; and
- To monitor the accessibility of bowhead whales to Inupiat hunters.

Specially-outfitted Twin Otter aircraft have an excellent safety record and are expected to be the survey aircraft. These aircraft will be specially modified for survey work and have been used extensively by NMFS, Alaska Department of Fish and Game, North Slope Borough, and LGL Limited during many marine mammal projects in Alaska, including industry-funded projects as recent as the 2006–2008 seasons. The aircraft will be provided with a comprehensive set of survival equipment appropriate to offshore surveys in the Arctic. For safety reasons, the aircraft will be operated with two pilots.

Aerial survey flights will begin around August 20, 2010. Surveys will then be flown daily during the shallow hazards survey 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 open-water season Shell will coordinate and cooperate with the aerial surveys conducted by MMS/NMFS and any other groups conducting surveys in the same region.

It is understood that shallow hazard survey timing and the specific location offshore of Harrison Bay are subject to change as a result of unpredictable weather and ice conditions. The aerial survey design is therefore intended to be flexible and able to adapt at short notice to changes in the operations.

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). Flying at a survey speed of 120 knots (138 mph) greatly increases the amount of area that can be surveyed, given aircraft limitations, with minimal effect on the ability to detect bowhead whales. 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 900–1,000+ (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. This will provide data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to the survey vessel) on the probability of detecting animals (*see* Davis *et al.* 1982; Miller *et al.* 1999; Thomas *et al.* 2002). The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along 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.

Shell will assemble the information needed to relate marine mammal observations to the locations of the survey vessel, and to the estimated received levels of industrial sounds at mammal locations. During the aerial surveys, Shell will record relevant information on other industry vessels, whaling vessels, low-flying aircraft, or any other human activities that are observed in the survey area.

Shell will also consult with MMS/National Marine Mammal Laboratory regarding coordination during the survey activities and real-time sharing of data. The aims will be:

- To ensure aircraft separation when both crews conduct surveys in the same general region;
- To coordinate the 2010 aerial survey projects in order to maximize consistency and minimize duplication;
- To use data from MMS's broad-scale surveys to supplement the results of the more site specific Shell surveys for purposes of assessing the effects of shallow hazard survey activities on whales and estimating "take by harassment";
- To maximize consistency with previous years' efforts insofar as feasible.

It is expected that raw bowhead sighting and flight-line data will be exchanged between MMS and Shell on a daily basis during the survey period, and that each team will also submit its sighting information to NMFS in Anchorage each day. After the Shell and MMS data files have been reviewed and finalized, they will be exchanged in digital form.

Shell is not aware of any other related aerial survey programs presently scheduled to occur in the Alaskan Beaufort Sea in areas where Shell is anticipated to be conducting survey operations during July–October 2010. However, one or more other programs are possible in support of other industry and research operations. If another aerial survey project were planned, Shell would seek to coordinate with that project to ensure aircraft separation, maximize consistency, minimize duplication, and share data.

During the late summer and fall, 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 shallow hazards survey operations has been designed to document whale distribution from about 25 mi (40 km) east of Shell's vessel 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 survey 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.

(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) supplied by Greeneridge. 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 shallow hazards surveys 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 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 survey 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).

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 2007–2009 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 3 of Shell's 4MP. The eastern-most site (#5 in Figure 3 of the 4MP) will be just east of Kaktovik and the western-most site (#1 in Figure 3 of the 4MP) will be in the vicinity of Harrison Bay. Site 2 will be located west of Prudhoe Bay. Sites 4 and 3 will be west of Camden Bay. 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 resulting in five equilateral triangles with 4.3-mi (7-km) element spacing. 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. 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 monitoring for whale calls from before August 15 until sometime before October 15, 2010.

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**).

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 re 1 μPa (rms) radii of the source vessel(s) 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 marine survey activities.

(2) Technical Reports

The results of Shell's 2010 open water marine survey monitoring program (*i.e.,* vessel-based, aerial, and acoustic), including estimates of "take" by harassment, will be presented in the "90-day" and Final Technical reports. The Technical Reports will include: (a) Summaries of monitoring effort (*e.g.,* total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals); (b) analyses of the effects of various factors influencing detectability of marine mammals (*e.g.,* sea state, number of observers, and fog/glare); (c) 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; (d) analyses of the effects of survey operations; (e) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability); (f) initial sighting distances versus airgun activity state; (g) closest point of approach versus airgun activity state; (h) observed behaviors and types of movements versus airgun activity state; (i) numbers of sightings/individuals seen versus airgun activity state; (j) distribution around the survey vessel versus airgun activity state; and (k) estimates of take by harassment. This information will be reported for both the vessel-based and aerial monitoring. In addition, Shell shall provide all spatial data on charts (always including vessel location) and make all data available in the report, preferably electronically, for integration with data from other companies. Shell shall also accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions 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 airgun 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 and Chukchi Seas open water marine survey programs. 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 shortly. 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 shallow hazards surveys 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 Seas 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 marine survey 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 open water marine survey program, Shell will report the same information as listed above as soon as operationally feasible to NMFS.

Negligible Impact and Small Numbers Analysis and 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 2010 open water marine surveys in the Beaufort and Chukchi Seas, and none are proposed to be authorized. Additionally, as discussed previously in this document, 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 of marine mammals may be exposed to sounds from marine survey activities more than once, the expanse of these multi-exposures are expected to be less extensive since both the animals and the survey vessels will be moving constantly in and out the survey areas.

The proposed marine survey areas in the Beaufort and Chukchi Seas are not known habitat for breeding or calving for marine mammals during the time of the proposed marine survey activities.

Although bowhead whales are observed feeding in the Beaufort and Chukchi Seas during the summer, some studies have shown that bowhead whales will continue to feed in areas of seismic operations (*e.g.,* Richardson *et al.* 2004). Therefore, it is reasonable to conclude that the marine surveys using active acoustic sources will not displace bowhead whales from their important feeding areas. Also, it is important to note that the sounds produced by the proposed Shell marine surveys are of much lower intensity than those produced by airgun arrays during a 3D or 2D seismic survey. Should bowheads choose to feed in the ensonified area instead of avoiding the sound, individuals may be exposed to sounds at or above 160 dB re 1 μPa (rms) when the survey vessel passes by. Depending on the direction and speed of the survey vessel, the duration of exposure is not expected to be more than 15 minutes (assuming the survey vessel is traveling at 4 knots (7.5 km/hr) and heading directly towards the whale but without engaging the whale inside the safety zone). While feeding in an area of increased anthropogenic sound even below NMFS current threshold for behavioral harassment for impulse sound, *i.e.* 160 dB re 1 μPa (rms), may potentially result in increased stress, it is not anticipated that the low received levels from marine surveys 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 (*see* review by Southall *et al.* 2007). Additionally, if an animal is excluded from the area (such as Harrison 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 area. However, there are multiple feeding areas nearby in the Beaufort Sea for bowhead whales to choose from. The disruption to feeding is not anticipated to have more than a negligible impact on the affected species or stock.

Beluga whales are less likely to occur in the proposed marine survey area than bowhead whales in Beaufort Sea. Should any belugas occur in the area of marine surveys, it is not expected that they would be exposed for a prolonged period of time, for the same reason discussed above due to the movement of survey vessel and animals. Gray whales, humpback whales, and harbor porpoises rarely occur in the Beaufort Sea, therefore, the potential effects to these species from the proposed open water marine surveys is expected to be close to none. The exposure of cetaceans to sounds produced by the proposed marine surveys 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 sound from the proposed marine surveys more than once during the time frame of the project. However, as discussed previously, due to the constant moving of the survey vessel, the probability of an individual pinniped being exposed to sound multiple times is much lower than if the source is stationary. Therefore, NMFS has determined that the exposure of pinnipeds to sounds produced by the proposed marine surveys in the Beaufort and Chukchi Seas 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.

Of the eight marine mammal species likely to occur in the proposed marine survey area, only the bowhead and humpback whales are listed as endangered under the ESA. The species are 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). The occurrence of humpback whales in the proposed marine survey areas is considered very rare. There is no critical habitat designated in the U.S. Arctic for the bowhead whale and humpback 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 marine survey activities, any missed feeding opportunities in the direct project area would be minor based on the fact that other feeding areas exist elsewhere.

The estimated takes proposed to be authorized represent 0.01% of the Beaufort Sea population of approximately 39,258 beluga whales (Allen and Angliss 2010), 0.004% of Bering Sea stock of approximately 48,215 harbor porpoises, 0.01% of the Eastern North Pacific stock of approximately 17,752 gray whales, 2.67% 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), and 0.21% of the Western North Pacific stock of approximately 938 humpback whales. The take estimates presented for bearded, ringed, and spotted seals represent 0.003, 0.06, and 0.002 percent of U.S. Arctic stocks of 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. In addition, the mitigation and monitoring measures (described previously in this document) proposed for inclusion in the IHA (if issued) are expected to reduce even further any potential disturbance to marine mammals.

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 finds that Shell's proposed 2010 open water marine surveys in the Beaufort and Chukchi Seas may result in the incidental take of small numbers of marine mammals, by Level B harassment only, and that the total taking from the marine surveys will have a negligible impact on the affected species or stocks.

Unmitigable Adverse Impact Analysis and Determination

NMFS has determined that Shell's proposed 2010 open water marine surveys in the Beaufort and Chukchi Seas will not have an unmitigable adverse impact on the availability of species or stocks for taking for subsistence uses. This determination is supported by information contained in this document and Shell's POC. Shell has adopted a spatial and temporal strategy for its Arctic open water marine surveys that should minimize impacts to subsistence hunters, which is discussed in detail below, broken into different subsistence activities.

(1) Bowhead Whales

During the proposed period of activity (July through October) most marine mammals are expected to be dispersed throughout the area, except during the peak of the bowhead whale migration in the Beaufort Sea, which occurs from late August into October. Bowhead whales are expected to be in the Canadian Beaufort Sea during much of the time prior to subsistence whaling and, therefore, are not expected to be affected by the site clearance and shallow hazard surveys prior to then. Further, site clearance and shallow hazards surveys will be conducted over 50–100 mi (80–160 km) west of the furthest west boundary of the traditional bowhead hunting waters used by Kaktovik hunters, 10–50 mi (16–80 km) west of Cross Island from where Nuiqsut hunters base their harvest, and over 35 miles east of the furthest east boundary of the traditional bowhead hunting waters used by Barrow hunters. In light of the small sound source for these surveys and resulting ensonified area > 160 dB (1,525 m) described previously in this document, the sheer distances from where these site clearance and shallow hazard surveys will occur from the areas of Kaktovik and Barrow bowhead hunts serve to mitigate any prospect of impact to the hunts. Site clearance and shallow hazard surveys will be timed to occur beyond the traditional boundary of Nuiqsut hunts, besides occurring 10–50 mi (16–80 km) west of Cross Island and "downstream" of this bowhead whale hunt, thereby mitigating the prospect of impact to Nuiqsut whaling. In addition, Shell will execute a communication plan and use communication and call centers located in coastal villages of the Beaufort Sea (*see* above) to communicate activities and routine vessel traffic with subsistence users throughout the period in which all surveys will be conducted. As a result of the distance and spatial location of site clearance and shallow hazard surveys from traditional bowhead whale subsistence harvest, any effects on the bowhead whale, as a subsistence resource, will be negligible.

Activities associated with Shell's planned ice gouge surveys in Camden Bay would have no or negligible effect on the availability of bowhead whales for the Kaktovik, Nuiqsut, and Barrow subsistence whaling harvests. Mitigation of the impact from ice gouge surveys includes the possible use of either an AUV, or conventional survey method without airguns, and timing and location of surveys. The AUV will be launched from the stern of a vessel and will survey the seafloor close to the

vessel. The vessel will transit an area, with the AUV surveying the area behind the vessel. Marine mammal observers onboard the vessel will help to ensure the AUV has a minimal impact on the environment. The AUV also has a Collision Avoidance System and operates without a towline, thereby reducing potential impact to marine mammals. Using bathymetric sonar or multi-beam echo sounder the AUV can record the gouges on the seafloor surface caused by ice keels. The Sub-bottom profiler can record layers beneath the surface to about 20 ft (6.1 m). The AUV is more maneuverable and able to complete surveys more quickly than a conventional survey. This reduces the duration that vessels producing sound must operate. Also, the ice gouge surveys will be timed to avoid locations east of Mary Sachs Entrance in Camden Bay during the bowhead subsistence harvest of Kaktovik. The ice gouge survey locations through Mary Sachs Entrance and out into Camden Bay are more than 40 mi (64 km) east of Cross Island, and given this distance plus the low-level sound source of the ice gouge surveys, this will mitigate impact to the Nuiqsut bowhead whale subsistence harvest. Timing of activities will be coordinated via the nearest communication and call centers operating in the Beaufort Sea, presumably in Kaktovik and Deadhorse. As a result of the timing, location, and lack of an airgun source for the ice gouge surveys, any effects on the bowhead whale, as a subsistence resource, will be negligible.

Ice gouge survey activities in the Chukchi Sea will be scheduled to avoid impact to bowhead whale subsistence harvests that could be conducted in the Chukchi Sea communities of Wainwright or Point Hope. Scheduling will be coordinated via the nearest communication and call center operating in the Chukchi Sea communities.

(2) Beluga Whales

Beluga are not a prevailing subsistence resource in the communities of Kaktovik, Nuiqsut, or Barrow. Thus, given the location and timing of site clearance and shallow hazards and ice gouge surveys in the Beaufort Sea, any such behavioral response by beluga to these activities would have no significant effect on them as a subsistence resource.

Belugas are a prevailing subsistence resource in the Chukchi Sea community of Pt. Lay. The Point Lay beluga hunt is concentrated in the first two weeks of July (but sometimes continues into August), when belugas are herded by hunters with boats into Kasegaluk Lagoon and harvested in shallow waters. Ice gouge survey activities in the Chukchi Sea will be scheduled to avoid the traditional subsistence beluga hunt in the community of Pt. Lay. Timing of any ice gouge survey activities will be coordinated via the nearest communication and call centers operating in the Chukchi Sea, presumably in Wainwright and Barrow.

(3) Seals

Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest of both Kaktovik and Nuiqsut. Seals can be hunted year-round, but are taken in highest numbers in the summer months in the Beaufort Sea (MMS 2008). Seal-hunting trips can take Nuiqsut hunters several miles offshore; however, the majority of seal hunting takes place closer to shore. The mouth of the Colville River is considered a productive seal hunting area (AES 2009), as well as the edge of the sea ice. Lease blocks where site clearance and shallow hazards surveys will occur are located over 15 mi (24 km) from the mouth of the Colville River, so there is less chance for impact on subsistence hunting for seals. Ice gouge surveys in Mary Sachs Entrance in Camden Bay will be conducted (AES 2009) over 30 miles from the westernmost extent of seal hunting by Kaktovik hunters (AES 2009). The remainder of ice gouge lines will be much further offshore than where Kaktovik seal hunts typically occur which is inside the barrier islands (AES 2009). It is assumed that effects on subsistence seal harvests would be negligible given the distances between Shell's proposed site clearance and shallow hazards and ice gouge surveys and the subsistence seal hunting areas of Nuiqsut and Kaktovik.

Seals are an important subsistence resource in the Chukchi Sea community of Wainwright. Ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring (May-July) which is before Shell's ice gouge survey would commence, but some harvest continues into the open water period. Hunting that does occur during the open water season generally occurs within 10 miles of the coastline (AES 2009), while the majority of ice gouge survey activity will be much further offshore. Timing of activities will be coordinated via the nearest communication and call centers operating in the Chukchi Sea, presumably in Wainwright and Barrow. It is assumed that effects on subsistence seal harvests would be negligible given the timing and distances between Shell's proposed ice gouge survey and the subsistence seal hunting area of Wainwright.

All survey activities will be operated in accordance with the procedures of Shell's Marine Mammal Monitoring and Mitigation Plan (4MP) that accompanies this program. This potential impact is mitigated by application of the procedures established in the 4MP and to be detailed in the POC. Adaptive mitigation measures may be employed during times of active scouting, whaling, or other subsistence hunting activities that occur within the traditional subsistence hunting areas of the potentially affected communities.

Shell states that it will continue its adopted spatial and temporal operational strategy that, when combined with its community outreach and engagement program, will provide effective protection to the bowhead migration and subsistence hunt.

Based on the above analysis, measures described in Shell's POC, the proposed mitigation and monitoring measures, and the project design, NMFS has determined that there will not be an unmitigable adverse impact on subsistence uses from Shell's 2010 open water marine survey activities in the Beaufort and Chukchi Seas.

Endangered Species Act (ESA)

There are two marine mammal species listed as endangered under the ESA with confirmed or possible occurrence in the proposed project area: the bowhead whale and the humpback whale. NMFS' Permits, Conservation and Education Division consulted with NMFS' Alaska Regional Office Division of Protected Resources 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. A Biological Opinion was issued on July 13, 2010, which concludes that issuance of an IHA is not likely to jeopardize the continued existence of the fin, humpback, or bowhead whale. NMFS has issued an Incidental Take Statement under this Biological Opinion which contains reasonable and prudent measures with implementing terms and conditions to minimize the effects of take of listed species.

National Environmental Policy Act (NEPA)

NMFS prepared an EA that includes an analysis of potential environmental effects associated with NMFS' issuance of an IHA to Shell to take marine mammals incidental to conducting its marine survey program in the Beaufort and Chukchi Seas during 2010 open water season. NMFS has finalized the

EA and prepared a FONSI for this action. Therefore, preparation of an EIS is not necessary.

Authorization

As a result of these determinations, NMFS has issued an IHA to Shell to take marine mammals incidental to its 2010 open water marine surveys in the Beaufort and Chukchi Seas, Alaska, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

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