DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XC562

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Seismic Survey in the Chukchi Sea, 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 Gulf of Mexico Inc. (Shell) to take, by harassment, small numbers of 13 species of marine mammals incidental to a marine survey program in the Chukchi Sea, Alaska, during the 2013 Arctic open-water season. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to Shell to take, by Level B harassment, 13 species of marine mammals during the specified activity.

DATES: Effective July 1, 2013, through October 31, 2013.

ADDRESSES: Inquiry for information on the incidental take authorization should be addressed to P. Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. A copy of the application containing a list of the references used in this document, NMFS' Environmental Assessment (EA), 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) 427–8401 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. Section 101(a)(5)(D) establishes a 45-day time limit for NMFS review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [''Level A harassment'']; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [''Level B harassment''].

Summary of Request

NMFS received an application on January 2, 2013, from Shell for the taking, by harassment, of marine mammals incidental to a marine surveys program in the Beaufort and Chukchi seas, Alaska, during the open-water season of 2013. Subsequently, Shell revised its proposed marine surveys program and limited its activities to the Chukchi Sea, and resubmitted an IHA application on March 25, 2013. Based on NMFS comments, Shell further revised its IHA application and submitted its final IHA application on April 2, 2013.

Description of the Specified Activity

Shell plans to complete a marine surveys program and conduct its equipment recovery and maintenance activity, during the 2013 open-water season in the Chukchi Sea. A total of three vessels would be utilized for the proposed open-water activities: the marine surveys would be conducted from a single vessel, a second vessel would be used for equipment recovery and maintenance activity at Burger A, and a third vessel may be used to provide logistical support to either and/or both operations. Overall, Shell's 2013 open-water marine surveys program includes the following three components:

- Chukchi Sea Offshore Ice Gouge Surveys;
- Chukchi Sea Offshore Site Clearance and Shallow Hazards Survey; and
- Equipment Recovery and Maintenance

Detailed locations of these activities are shown in Figures 1–1 through 1–3 of Shell's IHA application.

Ice and weather conditions will influence when and where the open-water marine surveys will be conducted. For initial planning purposes, Shell states that the offshore marine surveys and equipment recovery and maintenance would be conducted within the time frame of July through October 2013.

Chukchi Sea Offshore Ice Gouge Surveys

Ice gouge information is required for the design of potential pipelines and pipeline trenching and installation equipment. Ice gouges are created by ice keels that project from the bottom of ice, and gouge the seafloor sediment as the ice moves with the wind or currents. Ice gouge features can be mapped and surveyed, and by surveying the same locations from year to year, new gouges can be identified and the rate of ice gouging can be estimated. The resulting ice gouge information would assist Shell in predicting the probability, frequency, orientation, and depth of future ice gouges.

Shell plans to conduct ice gouge surveys along approximately 621 mi

(1,000 km) of tracklines in the Chukchi Sea in 2013, within the area denoted in Figure 1–1 of the IHA application. These surveys will: (a) Resurvey selected tracklines for ice gouge features to determine the rate or frequency of new ice gouges; and (b) map seafloor topography and characterize the upper 34 ft (10 m) of the seabed (seafloor and sub-seafloor) using acoustic methods. The ice gouge surveys will be conducted using the conventional survey method where the acoustic instrumentation will be towed behind the survey vessel. These acoustic instrumentation includes dual-frequency side scan sonar, single-beam bathymetric sonar, multi-beam bathymetric sonar, shallow sub-bottom profiler, and magnetometer.

Due to the low intensity and high frequency acoustic sources being used for the proposed ice gouge surveys, this activity is not expected to result in takes of marine mammals.

Chukchi Sea Site Clearance and Shallow Hazards Surveys

The proposed site clearance and shallow hazards surveys are to gather data on: (1) Bathymetry, (2) seabed topography and other seabed characteristics (e.g., ice gouges), (3) potential shallow geohazards (e.g., shallow faults and shallow gas zones), and (4) the presence of any possible archeological features (prehistoric or historic, e.g., middens, shipwrecks). Marine surveys for site clearance and shallow hazard surveys can be accomplished by one vessel with acoustic sources.

Shell plans to conduct site clearance and shallow hazards surveys along approximately 3,200 kilometers (km) of tracklines in the Chukchi Sea in 2013 (see Figure 1–2 of the IHA application). These surveys would characterize the upper 1,000 meters (m) (3,128 feet [ft]) of the seabed and sub seafloor topography and measure water depths of potential exploratory drilling locations using acoustic methods. The site clearance and shallow hazard surveys would be conducted using the conventional survey method where the acoustic instrumentation will be towed behind the survey vessel. The acoustic instrumentation used in site clearance and shallow hazards surveys is largely the same as those for the offshore ice gouge surveys, but also includes a 4 x 10 cubic inch (in^3) airgun array.

Equipment Recovery and Maintenance

Shell's proposed equipment recovery and maintenance activities would occur at the Burger A well site in the Chukchi Sea (see Figure 1–3 of the IHA application). The equipment recovery and maintenance activity would be accomplished by one vessel operating in dynamic positioning (DP) mode for an extended period over the drilling site. The vessel may be resupplied during the activity by vessel or aircraft.

Work would be conducted subsea within the mudline cellar (MLC; ~ 20 ft wide by 40 ft. deep excavation dug for the Burger A wellhead during 2012 drilling at this well site) with a suite of Remotely Operated Vehicles (ROV) and divers that would recover equipment left sub-mudline on the well head during the 2012 open water drilling season. The survey vessel would be dynamically positioned at the well site for up to ~28 days while subsurface equipment recovery and maintenance occurs, however Shell anticipates this work being accomplished in less than 28 days. During this planned work scope the state and integrity of the well would not be changed since no form of entry will be made into the well.

Acoustic Equipment and Vessels Planned to be Used

For the proposed site clearance and shallow hazards surveys, Shell plans to use the same 4 x 10 in^3 airgun array configuration that was used during site clearance and shallow hazards surveys in the Chukchi Sea in 2008 and 2009. Measurements during these two years occurred at three locations: Honeyguide (west of the Crackerjack prospect), Crackerjack, and Burger. The distances to various threshold radii from those measurements are shown in Table 1. The 160 dB (rms) re 1 μPa radius that was measured at the Burger location was the largest of the three sites.

TABLE 1—MEASURED DISTANCES IN (METERS) TO RECEIVED SOUND LEVELS FROM A 4 X 10^3 AIRGUN ARRAY AT THREE LOCATIONS IN THE ALASKAN CHUKCHI SEA

Location	Received Sound Level (dB re 1 μPa rms)			
	190	180	160	120
Honeyguide	41	100	600	22,000
Crackerjack	50	160	1,400	24,000
Burger	39	150	1,800	31,000

Sound source characteristics that would be used during the site clearance and shallow hazard surveys and ice gouge surveys include single-beam bathymetric sonar, multi-beam bathymetric sonar, dual frequency side-scan sonar, shallow sub-bottom profiler, and an ultra-short baseline acoustic positioning system. Representative source characteristics of these acoustic instrumentation were measured during Statoil's 2011 marine survey program in the Chukchi Sea (Warner and McCrodan 2011), and are listed in Table 2.

TABLE 2—SOURCE CHARACTERISTICS AND DISTANCES TO 160 dB (RMS) RE 1 μPa SOUND LEVELS FROM ACOUSTIC INSTRUMENTATION MEASURED IN THE CHUKCHI SEA

Instrument type	Model	Center Frequency (kHz)	Frequency Range (kHz)	Beam Width	Nominal Source Level (dB re 1 μPa rms)	In-beam 160 dB Distance (m)	Out-of-beam 160 dB Distance
Single-beam sonar	Simrad EA502	12 kHz	8–20 kHz	<10°	218.0	40	40 m.
Multi-beam bathymetric sonar.	Kongsberg EM2040	220 kHz	200–240	<2°	187.4	0	0 m.
Side-scan sonar	GeoAcoustics 159D	110	100–120	<2°	211.5	230	NA.
Sub-bottom profiler	Kongsberg SBP300	3–7	3–7	15°	195.9	30	3 m.

TABLE 2—SOURCE CHARACTERISTICS AND DISTANCES TO 160 dB (RMS) RE 1 μPa SOUND LEVELS FROM ACOUSTIC INSTRUMENTATION MEASURED IN THE CHUKCHI SEA—Continued

Instrument type	Model	Center Frequency (kHz)	Frequency Range (kHz)	Beam Width	Nominal Source Level (dB re 1 μPa rms)	In-beam 160 dB Distance (m)	Out-of-beam 160 dB Distance
Ultra-short baseline acoustic positioning system.	SonarDyne Ranger Pro.	27	20–30	NA	215.1	47	8 m.

For Shell's equipment recovery and maintenance at the Burger A well site where drilling took place in 2012, a vessel would be deployed at or near the well site using dynamic positioning thrusters while remotely operated vehicles or divers are used to perform the required activities. Sounds produced by the vessel while in dynamic positioning mode would be non-impulsive in nature and are thus evaluated at the ≥120 dB (rms) re 1 μPa.

In 2011, Statoil conducted geotechnical coring operations in the Chukchi Sea using the vessel *Fugro Synergy.* Measurements were taken using bottom founded recorders at 50 m (164 ft), 100 m (328 ft), and 1 km (0.6 mi) away from the borehole while the vessel was in dynamic positioning mode (Warner and McCrodan 2011). Sound levels measured at the recorder 1 km (0.6 mi) away ranged from 119 dB (rms) to 129 dB (rms) re 1 μPa. A propagation curve fit to the data and encompassing 90 percent of all measured values during the period of strongest sound emissions estimated sound levels would drop below 120 dB (rms) re 1 μPa at 2.3 km (1.4 mi).

Acoustic measurements of the *Nordica* in dynamic positioning mode while supporting Shell's 2012 drilling operation in the Chukchi Sea were made from multiple recorders deployed to monitor sounds from the overall drilling operation. Distances to these recorders ranged from 1.3 km (0.8 mi) to 7.9 km (4.9 mi) and maximum sound pressure levels ranged from 112.7 dB (rms) to 129.9 dB (rms) re 1 μPa. Preliminary analyses of these data indicate the maximum 120 dB (rms) re 1 μPa distance was approximately 4 km (2.5 mi) from the vessel. These same recorders measured sounds produced by the *Tor Viking II* while it operated near the Discoverer drill rig in 2012. The nature of the operations conducted by the *Tor Viking II* during the reported measurement periods varied and included activities such as anchor handling, circling, and possibly holding position using dynamic positioning thrusters. Distances to the 120 dB (rms) re 1 μPa level were estimated at 10 km (6 mi), 13 km (8 mi), and 25 km (15.5 mi) during these various measurement periods.

The vessel from which equipment recovery and maintenance would be conducted has not yet been determined. Under most circumstances, sounds from dynamic positioning thrusters are expected to be well below 120 dB (rms) re 1 μPa at distances greater than 10 km (6 mi). However, since some of the activities conducted by the *Tor Viking II* at the Burger A well site in 2012 may have included dynamic positioning, the 13 km (8 mi) distance has been selected as the estimated ≥120 dB (rms) re 1 μPa distance used in the calculations of potential Level B harassment below. A circle with a radius of 13 km (8 mi) results in an estimated area of 531 km^2 (205 mi^2) that may be exposed to continuous sounds ≥120 dB (rms) re 1 μPa.

Comments and Responses

A notice of NMFS' proposal to issue an IHA to Shell was published in the **Federal Register** on May 14, 2012 (78 FR 28412). 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 and the availability of marine mammals for subsistence uses. During the 30-day public comment period, NMFS received comment letters from the following: the Marine Mammal Commission (Commission); the Alaska Eskimo Whaling Commission (AEWC); the Alaska Wilderness League (AWL), Center for Biological Diversity, Earthjustice, Greenpeace, Natural Resources Defense Council, Northern Alaska Environmental Center, Sierra Club, and the Wilderness Society (collectively ''AWL''), Bureau of Ocean Energy Management (BOEM), and one private citizen.

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.

MMPA Concerns:

Comment 1: The Commission recommends that NMFS continue to include proposed incidental harassment authorization language at the end of **Federal Register** notices but ensure that the language is consistent with that referenced in the main body of the **Federal Register** notice.

Response: NMFS agrees that this is a good recommendation and plans to include proposed incidental harassment authorization language at the end of **Federal Register** notices for Arctic oil and gas IHAs. NMFS will also try to ensure that the language is consistent with that referenced in the main body of the **Federal Register** notice.

Comment 2: The Commission recommends that NMFS require Shell to revise its take estimates to include Level B harassment takes associated with its ice gouge survey. In addition, AWL states that NMFS has not justified its decision to remove entirely Shell's ice gouge surveys from the ambit of the MMPA.

Response: NMFS does not agree with the Commission's recommendation and AWL's statement. As stated in the **Federal Register** notice for the proposed IHA and explained in Shell's IHA application, due to the low intensity and high frequency acoustic sources being used for the ice gouge surveys, this activity is not expected to result in takes of marine mammals. The acoustic equipment proposed to be used in the ice gouge survey includes single-beam bathymetric sonar, multi-beam bathymetric sonar, dual frequency side-scan sonar, and shallow sub-bottom profiler. Representative instruments of these types were measured during Statoil's 2011 site survey program in the Chukchi Sea. Operating frequencies, beam widths, and distances to 160 dB re 1 μPa for these high frequency instruments are summarized in Table 2. Due to the rapid attenuation of these higher frequency sounds and the narrow beam-widths where most of the sound energy is present, the impact from operating these instruments is not expected to be any greater than the operation of the vessel itself. Therefore, NMFS does not believe use of these

instruments would cause takes of marine mammals as defined under the MMPA.

Impacts Analysis:

Comment 3: The AEWC states that it wants to emphasize the growing importance of the fall bowhead whale hunt for Barrow and the Chukchi Sea communities. The AEWC states that it is concerned about NMFS' statement in the **Federal Register** notice for the proposed IHA that the subsistence hunt of the bowhead whales in Chukchi Sea communities ''takes place almost exclusively in the spring…'' The AEWC points out that its Chukchi Sea communities are increasingly being forced to look to fall hunting opportunities as ice conditions in the spring are making it more dangerous and difficult to meet its quotas. The AEWC states that this spring only 11 whales were taken: four in Savoonga, two in Gambell, and five in Pt. Hope. No whales were taken in Barrow. The AEWC asks NMFS to discuss the growing importance of the fall hunt for the communities.

Response: NMFS appreciates the additional information clarifying the role of the fall bowhead whale hunt in subsistence harvest activities. NMFS' analyses provided in the **Federal Register** notice for the proposed IHA was based on historical data as the most recent data from the same season may not be available at the time of analysis. NMFS has incorporated this information into the subsistence impact analysis in this document.

Comment 4: The BOEM states that there is an incorrect statement on page 28422 of the **Federal Register** notice for the proposed IHA where it states ''During the survey period most marine mammals are expected to be dispersed throughout the area, except during the peak of the bowhead whale migration through the Chukchi Seas, which occurs from late August into October.'' BOEM comments that NMFS use of the word ''peak'' is problematic. BOEM further states that ''the bowhead migration occurs in surges of groups moving from Canadian waters to the Alaskan Beaufort Sea beginning in August. Some bowheads are sporadically present in the proposed ancillary activity area from July 6 to December 25, but the bowhead migration begins to enter the activity area during late August, and more through the activity area as late November 26, per tagged whale data and aerial survey data. There would be few bowheads in the vicinity of the ancillary activities during July and August, the proposed period when much of the activity is proposed.''

Response: NMFS revised the sentence to ''During the survey period most marine mammals are expected to be dispersed throughout the area, with most of the bowhead whales migration through the Chukchi Sea between late August and late November.''

Comment 5: The AWL states that there are large gaps in basic scientific information about both the Chukchi Sea ecosystem and marine mammal responses to noise, and that these gaps prevent adequate analysis of the potential impacts of Shell's proposed seismic survey on wildlife. The AWL concludes that the gaps in information preclude defensible small numbers and negligible impact findings under the MMPA, constrain the designing of adequate mitigation measures, and undermine assessment of the potential effects of the proposed surveying pursuant to NEPA.

Response: Although NMFS agrees that it would be desirable to obtain additional information about both the Chukchi Sea ecosystem and marine mammal responses to noise in general, NMFS believes it has sufficient information to support its analysis of the potential impacts of Shell's proposed marine surveys on wildlife. 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 the impacts would be negligible. The **Federal Register** notice for the proposed IHA, NMFS EA for the issuance of IHAs to take marine mammals incidental to open-water marine and seismic surveys in 2013, and this document all provide detailed analysis using the best available scientific information that enables NMFS to make the required determinations. In addition, the required monitoring and mitigation measures prescribed in the IHA NMFS issued to Shell will further reduce any potential impacts of the proposed marine surveys on marine mammals.

Comment 6: The AWL states that NMFS may not issue the IHA because it has not negated the possibility of serious injury from Shell's airguns. Further, the AWL noted that 18 years ago, NMFS once stated that permanent hearing loss qualifies as serious injury (60 FR 28381, May 31, 1995). A private citizen further states that the marine survey is ''massive deadly'' to marine mammals.

Response: NMFS does not agree with the private citizen and AWL's assessment. In fact, NMFS was able to make a preliminary determination in the **Federal Register** for the proposed IHA to Shell to take marine mammals incidental to its open-water marine surveys. In addition, NMFS' preliminary determination states that the potential effects would be Level B behavioral harassment by small numbers of marine mammals in the project vicinity, and no injury, serious injury, or mortality is expected.

Concerning the AWL's comments on NMFS 1995 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 1995, 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. Additionally, NMFS has required monitoring and mitigation measures to negate the possibility of marine mammals being seriously injured or killed 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 7: The Commission requests NMFS use species-specific maximum density estimates as a basis for estimating the expected number of takes.

Response: 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 adjustments were used to arrive at ''average'' and ''maximum'' estimates. The species-specific estimation of these numbers is provided in the **Federal Register** notice for the proposed IHA. 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 Chukchi Sea survey area, but whose chance occurrence has been documented in the past, such as killer whales, narwhales, and harbor porpoises, NMFS allotted a few numbers of these species to allow unexpected takes of these species.

Comment 8: The Commission requests NMFS require Shell to (1) estimate the numbers of marine mammals taken in the ice gouge survey and (2) base that estimate on the 120-dB re 1 μPa threshold rather than the 160-dB re 1 μPa threshold. For the second part of this comment, the Commission attached its comments to NMFS regarding NMFS Southwest Fisheries Science Center (SWFSC) fisheries research activities and outlined reasons that acoustic sources used in ice gouge surveys have temporal and spectral characteristics that suggest a lower threshold would be more precautionary.

Response: For the Commission's first comment regarding potential take of marine mammals in ice gouge survey, please refer to *Response* to *Comment 2.* As stated in that *Response,* NMFS does not believe that marine mammals would be taken as a result of the ice gouge survey.

Regarding the Commission's second comment, NMFS does not agree with the Commission's statement that acoustic sources used in ice gouge surveys have temporal and spectral characteristics that suggest a lower threshold is appropriate. Continuous sounds are those whose sound pressure level remains above that of the ambient sound, with negligibly small fluctuations in level (NIOSH, 1998; ANSI, 2005), while intermittent sounds are defined as sounds with interrupted levels of low or no sound (NIOSH, 1998). Thus, echosounder signals are not continuous sounds but rather intermittent sounds. Intermittent sounds can further be defined as either impulsive or non-impulsive. Impulsive sounds have been defined as sounds which are typically transient, brief (< 1 sec), broadband, and consist of a high peak pressure with rapid rise time and rapid decay (ANSI, 1986; NIOSH, 1998). Echosounder signals also have durations that are typically very brief (< 1 sec), with temporal characteristics that more closely resemble those of impulsive sounds than non-impulsive sounds, which typically have more gradual rise times and longer decays (ANSI, 1995; NIOSH, 1998). With regard to behavioral thresholds, we therefore consider the temporal and spectral characteristics of echosounder signals to more closely resemble those of an impulse sound than a continuous sound.

The Commission suggests that, for certain sources considered here, the interval between pulses would not be discernible to the animal, thus rendering them effectively continuous. However, an echosounder's ''rapid staccato'' of pulse trains is emitted in a similar fashion as odontocete echolocation click trains. Research indicates that marine mammals, in general, have extremely fine auditory temporal resolution and can detect each signal separately (e.g., Au *et al.,* 1988; Dolphin *et al.,* 1995; Supin and Popov, 1995; Mooney *et al.,* 2009), especially for species with echolocation capabilities. Therefore, it is highly unlikely that marine mammals would perceive echosounder signals as being continuous.

In conclusion, echosounder signals are intermittent rather than continuous signals, and the fine temporal resolution of the marine mammal auditory system allows them to perceive these sounds as such. Further, the physical characteristics of these signals indicate a greater similarity to the way that intermittent, impulsive sounds are received. Therefore, the 160-dB threshold (typically associated with impulsive sources) is more appropriate than the 120-dB threshold (typically associated with continuous sources) for estimating takes by behavioral harassment incidental to use of such sources.

Finally, we agree with the Commission's recommendation to revise existing acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, and are currently in the process of producing such revisions. In particular, NMFS recognizes the importance of context (e.g., behavioral state of the animals, distance) in behavioral responses. The current behavioral categorization (i.e., impulse vs. continuous) does not account for context and is not appropriate for all sound sources. Thus, updated NOAA Acoustic Guidance (*http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm*) will more appropriately categorize behavioral harassment criteria by activity type.

Comment 9: The Commission requests NMFS consult with experts in the field of sound propagation and marine mammal hearing to revise the acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, including shallow penetration subbottom profilers, echosounders, and side-scan sonar.

Response: NMFS is in the process of developing revised acoustic criteria and thresholds to for a variety of sources. The revised acoustic criteria will be peer-reviewed and made available for public comment. Until that process is complete, it is not appropriate to apply the new criteria and thresholds in any incidental take authorization. Instead, NMFS will continue its longstanding practice of considering specific modifications to the acoustic criteria and thresholds currently employed for incidental take authorizations only after providing the public with an opportunity for review and comment and responding to the comments.

Comment 10: The Commission requests NMFS require Shell to calculate the size of the Level A and B harassment zones for the ice gouge survey, using the 120-dB re 1 μPa isopleth for the shallow penetration sub-bottom profiler as the basis for determining the distance to the Level B disturbance zone.

Response: As noted in the **Federal Register** notice for the proposed IHA, a level A harassment zone for the ice gouge survey either does not exist or is expected to be in close proximity of the survey vessel. The sizes of the Level B harassment zones (received level at 160 dB re 1 μPa) for the ice gouge survey for various sources are listed in Table 2 of the **Federal Register** notice for the proposed IHA as well as in this

document. NMFS does not agree with the Commission that it is appropriate to use the 120-dB re 1 μPa isopleth for the shallow penetration sub-bottom profiler (as well as other acoustic equipment used in the ice gouge survey) as the basis for determining the distance to the Level B disturbance zone, with reasons given in *Response* to *Comment 8* above.

Comment 11: The AWL claims that NMFS underestimated the number of animals that would be harassed from Shell's surveying because it calculates harassment from Shell's proposed surveying based on the exposure of marine mammals to impulsive sounds at or above 160 dB. The AWL states that this uniform approach to harassment does not take into account known reactions of marine mammals in the Arctic to levels of noise well below 160 dB. Without citing specific research, the AWL claims that ''for harbor porpoises, behavioral changes, including exclusion from an area, can occur at received levels from 90–110 dB [near ambient level] or lower,'' and beluga whales ''are known to alter their migration paths in response to ice breaker noise at received levels as low as 80 dB [quiet ambient level].'' The AWL further appointed out that NMFS acknowledged the potential for behavioral disturbance to belugas at distances of 10–20 km and bowhead whales react to sound level lower than 160 dB.

Response: NMFS does not agree with AWL's assessment on acoustic effects of marine mammals. First, the AWL did not provide a reference on harbor porpoise behavioral responses and exclusion from an area to received levels at 90–110 dB or lower, which is near the ambient noise level. Second, for the beluga whale example at quiet ambient level, although also not supported by a reference, such a deviation could be attributed to noise exposure to continuous sound (icebreaker), rather than exposure to seismic impulses. Additionally, as Shell does not intend to use icebreakers during its operations, statements regarding beluga reactions to icebreaker noise are not relevant to this activity. Concerning the behavioral disturbance by belugas at distances of 10–20 km, there was no mention of received level, so it is irrelevant to the AWL's argument concerning 160 dB received noise levels.

Although some studies have shown bowhead responses to received seismic impulses under 160 dB re 1 μPa, the best information available to date 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, as stated in the past, NMFS does not believe that minor course corrections during a migration will always 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 potentially biologically significant or 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).

Currently NMFS is working on revising its noise exposure criteria based on the best and most recent scientific information. These criteria will be used to develop methodologies to calculate behavioral responses of marine mammals exposed to sound associated with seismic surveys (primary source is airguns). Nevertheless, at the current stage and until the updated criteria are available (i.e., undergone full evaluation including internal review, peer review, and public comment), 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 12: The AWL states that NMFS should examine more closely the effects of noise from dynamic positioning. The AWL states that considering that the vessel that would be conducting the operations has not yet been identified, NMFS must follow the precautionary principle and base take estimates on the 25 km 120-dB distance.

Response: NMFS provided a detailed analysis and evaluation on the potential effects of noise from dynamic positioning on the marine environment in the **Federal Register** notice for the proposed IHA and EA, as well as in this document. As stated in the analysis, several choices for acoustic modeling of dynamic positioning are available based on prior measurements of vessels

conducting such activities. The loudest noise source seemed to be the Tor Viking II during Shell's 2012 drilling operations in the Chukchi Sea; the 120 dB re 1 μPa received levels from the *Tor Viking* were measured at 10 km (6 mi), 13 km (8 mi), and 25 km (15.5 mi) during these various measurement periods. Nevertheless, various activities other than the dynamic positioning operation were being performed at the time measurements were conducted, such as anchor handling and cycling. Therefore, NMFS does not consider that the largest radius represents the most accurate Level B harassment zone since for Shell's proposed 2013 marine surveys, the supporting vessel during equipment recovery and maintenance activities would only be engaged in dynamic position while supporting diving operations. Therefore, radius of 13 km (8 mi) was chosen as the zone for Level B behavioral harassment prior to SSV tests being conducted.

Comment 13: AWL argues that the effects of ice gouge surveying should be considered. AWL states that NMFS' dismissal of potential effects based on marine mammal hearing is not adequately supported. Citing a comment letter by David E. Bain submitted to NMFS in 2010, the AWL argues 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 surveys in the Chukchi Sea in its **Federal Register** for the proposed IHA. As stated in the notice as well as the EA, the reason NMFS does not think take of marine mammals is likely from ice gouge surveys 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. NMFS has addressed Dr. Bain's comment letter concerning his above five points in the **Federal Register** for the issuance of an IHA to Shell in 2010 (75 FR 49710; August 13, 2010), and the following is the summary.

Although it is possible that juvenile animals could have better hearing at high-frequency ranges similar to humans, the overall sensitivity that defines hearing is believed to be more related to different hearing groups (see Southall *et al.* 2007) than to animals' 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 manufactures' specifications 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 have these acoustic devices measured at the SSV tests. The SSV reports from Shell's 2010 90-day monitoring report provided a detailed description of the acoustic characteristics of the acoustic devices used in ice gouge surveys, and none of the equipment has significant sidebands that could affect marine mammals. Please refer to Shell's 2010 90-day monitoring report for detailed descriptions of the acoustic equipment used in ice gouge surveys (Reiser *et al.* 2011).

In regards 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 bowhead and other baleen whales, 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 lies between 10 to 90 kHz, and sensitivity falls sharply above 100 kHz.

Mitigation:

Comment 14: AEWC requested that NMFS incorporate the following provisions of the 2013 CAA as binding mitigation measures in the IHA issued to Shell: Section 202(a) and (c): Com-Center General Communications Scheme; Section 204: Standardized Log Books; Section 302: Barge and Transit Vessel Operations; Section 402: Sound Signature Tests; Section 501: General provisions for Avoiding Interference with Bowhead Whales or Subsistence Whale Hunting Activities; Section 502(b): Limitations on Geophysical Activity in the Chukchi Sea; Section 505: Termination of Operations and Transit Through the Bering Strait; and Title VI, Sections 601 and 602: Late Season Seismic Operations.

Response: NMFS has incorporated the above provisions of the 2013 CAA into the IHA issued to Shell, as these measures will help ensure there is no unmitigable adverse impact on the availability of affected species or stock(s) for subsistence uses.

Comment 15: The Commission requests NMFS require Shell to not initiate or continue seismic activities if (1) an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged

in a non-migratory, significant biological behavior (e.g., feeding, socializing)) is observed within the 160-dB re 1 µPa zone or (2) a female-calf pair is observed within the 120-dB re 1 µPa zone.

Response: NMFS did not propose the suspension of seismic activities for an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class) within the Level B harassment zone of 160 dB because the size of the zone is very small (1,800 m radius), and it is not likely an aggregation of 12 whales could occur in such a small zone. In addition, given the seismic vessel would be moving at a speed of 4—5 knots, and assuming the whales would be relatively stationary, the exposure of such aggregation of whales to received levels above 160 dB re 1 µPa would be less than 13 minutes. Nevertheless, NMFS has worked with Shell to include in the IHA the Commission's recommendation that Shell not initiate or continue seismic activities if an aggregation of bowhead or gray whales (12 or more whales of any age/sex class that appear to be engaged in a non-migratory, significant biological behavior) is observed within the 160-dB re 1 µPa isopleth.

However, NMFS does not agree with the Commission's recommendation that suspension of seismic activities is warranted for a female-calf pair within the 120-dB re 1 µPa zone when the animals are not likely to be harassed. Although it has been suggested that female baleen whales with calves ''show a heightened response to noise and disturbance,'' there is no evidence that such ''heightened response'' is biologically significant orconstitutes a ''take'' under the MMPA. Additionally, in the Chukchi Sea, the migratory corridor for bowhead whales is wider and more open, thus the 120–dB ensonified zone would be unlikely to impede bowhead whale migration. The animals would be able to swim around the ensonified area.

Comment 16: The AWL states NMFS should include provisions in the IHA that restrict Shell's operations based on geographic location, and/or time of year, such as restrict activity in certain areas, including subsistence use areas, areas of high productivity or diversity; areas that are important for feeding, migration, or other parts of the life history of species; or areas of biogenic habitat, structure-forming habitat, or habitat for endangered or threatened species.

Response: While processing the proposed IHA, NMFS has worked with Shell and conducted extensive analysis on the areas where Shell's proposed open-water marine surveys would occur. The areas Shell proposed to have its proposed marine surveys are analyzed in the proposed IHA process, during the section 7 consultation under the ESA, as well as under the NEPA analysis for preparing the EA. However, NMFS did not find that further restriction is needed given that no areas of high productivity or diversity, areas that are important for feeding and migration, or critical habitat for endangered or threatened species were found. Nevertheless, time and area certain restrictions are included in the IHA to minimize potential impacts on subsistence activities which are consistent with the CAA Shell has signed. These time and area restrictions are:

- Vessels transitting east of Bullen Point to the Canadian border should remain at least five miles offshore during transit along the coast, provided ice and sea condition allow,
- Vessels should remain as far offshore as weather and ice conditions allow, and at least five miles offshore during transit,
- From August 31 to October 31 vessels in the Chukchi Sea or Beaufort Sea shall remain at least 20 miles offshore of the coast of Alaska from Icy Cape in the Chukchi Sea to Pitt Point on the east side of Smith Bay in the Beaufort Sea whether in transit or engaging in activities in support of oil and gas operations unless ice conditions or an emergency that threatens the safety of the vessel or crew prevents compliance with this requirement,
- Beginning September 15, and ending with the close of the fall bowhead whale hunt, if Wainwright, Pt. Lay, or Pt. Hope intend to whale in the Chukchi Sea, no more than two geophysical activities employing geophysical equipment will occur at any one time in the Chukchi Sea. During the fall bowhead whale hunt, geophysical equipment will not be used within 30 miles of any point along the Chukchi Sea coastline. Industry participants will contact the Whaling Captains' Associations of each villages to determine if a village is prepared to whale and will notify the AEWC of any response, and
- All Industry participant vessels shall complete operations in time to allow such vessels to complete transit through the Bering Strait to a point south of 59 degrees North latitude no later than November 15, 2013.

Comment 17: The AWL states that NMFS should examine imposing requirements for the use of new technology that could reduce the footprint of seismic exploration. The AWL cited an expert conference in February in Silver Spring, Maryland, by NMFS on alternative technologies for offshore energy production and requested that NMFS consider (1) mandating the use of marine vibroseis or other technologies in some or all of the survey area; (2) mandating the testing of marine vibroseis in a pilot area, precedent to a decision to permit seismic activity, with an obligation to accrue data on environmental impacts; (3) deferring the permitting of surveys in part or all of the survey area until effective mitigative technologies, such as marine vibroseis, become available; (4) providing incentives for Shell's use of these technologies as was done for passive acoustic monitoring systems; and (5) exacting funds from Shell to support accelerated mitigation research in this area.

Response: First, the February workshop (not an ''expert conference'') in Silver Spring, Maryland, titled Quieting Technologies for Reducing Noise during Seismic Surveying and Pile Driving, was convened by BOEM, not NMFS. The goals of the workshop, as stated in the Web site of the workshop, were to (1) review and examine recent developments (existing, emerging, and potential) in quieting technologies for seismic surveying, whether proposed or in development; (2) identify the requirements for operation and limitations for using these technologies; (3) evaluate data quality and cost-effectiveness of these technologies as compared to that from existing marine acoustic technologies; (4) identify the acoustic characteristics of new technologies in varying environments compared to that from existing technologies; (5) examine potential environmental impacts from these technologies; (6) identify which technologies, if any, provide the most promise for full or partial traditional use and specify the conditions that might warrant their use (e.g., specific limitations to water depth, use in Marine Protected Areas, etc.); and (7) identify next steps, if appropriate, for the further development of these technologies, including potential incentives for field testing. Most of these technologies are still in research and development stages and have not been field tested. The workshop provided a forum for discussion and evaluation of such technologies, including vibroseis. NMFS supports and encourages both the development and use of technologies that will reduce impacts to marine mammals and other marine species. These alternative technologies will likely be adopted for use to replace some subset of future seismic survey

activities once their development is further along and their environmental impacts, especially as compared to seismic airguns, are better understood. . However, NMFS does not believe it can currently mandate the use of such technologies.

Monitoring:

Comment 18: The Commission requests NMFS require Shell to conduct sound source verification (SSV) for the ice gouge survey at varying depths. The Commission reasons that it is particularly important for the ice gouge survey because it would be conducted in relatively shallow nearshore waters where propagation models are of limited utility and bottom topography is more influential in these cases.

Response: NMFS does not agree with the Commission's assessment that propagation models are of limited utility in areas of relatively shallow waters where ice gouge surveys are proposed. Nevertheless, SSV tests will be performed to confirm the modeled sound propagation provided in the **Federal Register** notice for the proposed IHA. However, since the difference of water depth in the proposed ice gouge survey area is relatively small (between 12 and 42 m), NMFS does not believe SSV at varying water depth increments is necessary to yield meaningful differences in propagation distances.

Comment 19: The Commission requests NMFS only authorize an in-season adjustment in the size of the exclusion and/or disturbance zones if the size(s) of the estimated zones are determined to be inadequate. The Commission states that the purpose of SSV is to ensure protection of marine mammals, and one way to reduce risk to marine mammals would be to only allow expansion of the exclusion and/or disturbance zones.

Response: NMFS does not agree with the Commission's recommendation. While may seem to be more protective to increase the exclusion zone if the effectiveness of visual-based marine mammal monitoring remains the same regardless of the size of the zone, the actual result may not be so. For example, when the SSV suggests that the exclusion and/or disturbance zones are smaller than the ones modeled and monitoring still focus on the larger modeled zones, it is likely that the effectiveness of marine mammal monitoring could be reduced as the area to be monitored would be larger than necessary. In addition, larger than realistic exclusion zones would cause unnecessary power-down and shutdowns, which could increase the total duration of the marine surveys, and causes unnecessary impacts to the marine environment.

Comment 20: The Commission requests NMFS require Shell to deploy a sufficient number of trained and experienced, NMFS-approved vessel-based observers on the ice gouge survey vessel to ensure adequate monitoring of the Level A and B harassment zones during daylight hours throughout the entire survey period.

Response: As stated in the **Federal Register** notice for the proposed IHA, the level A harassment zone for the ice gouge survey either does not exist or is expected in close proximity of the survey vessel. Nevertheless, Shell is required to deploy a sufficient number of trained and experienced, NMFS-approved vessel-based protected species observers (PSOs) on the ice gouge survey vessel to ensure adequate monitoring of marine mammals during daylight hours throughout the entire survey period.

Comment 21: The Commission requests NMFS require Shell to monitor for marine mammals 30 minutes before, during, and 30 minutes after survey operations and other activities have ceased.

Response: Shell is required to monitor for marine mammals 30 minutes before, during, and 30 minutes after survey operations and other activities have ceased.

Comment 22: The Commission requests NMFS encourage Shell to deploy additional protected species observers to (1) increase the probability of detecting all marine mammals in or approaching the Level A and B harassment zones and (2) assist in the collection of data on activities, behaviors, and movements of marine mammals around the source.

Response: NMFS agrees that an adequate number of PSOs is critical to ensure complete coverage in visual monitoring and implementing mitigation measures. While it is reasonable to conclude that additional PSOs would increase detection capability to a certain degree, the number of PSOs that can be stationed on vessels is limited by the available berth spaces. Shell plans to have 4 to 5 PSOs aboard the survey vessel and will have 100% monitoring coverage during all periods of survey operations in daylight. In addition, each PSO is limited to maximum of 4 consecutive hours per watch and maximum of 12 hours of watch time per day. NMFS believes that the number of PSOs onboard is adequate given the limited space available on the survey vessel.

Comment 23: The Commission requests NMFS require Shell to report the preliminary results of its in-situ sound source and sound propagation measurements within five days.

Response: NMFS requires Shell to report the preliminary results of the in-situ SSV tests within five days of completing the tests, followed by a report in 14 days. This will allow Shell to review the initial results and to catch any error that might be overlooked during the initial five-day reporting.

Comment 24: The AWL states that the proposed IHA's mitigation measures rely on visual monitoring of exclusion zones to keep marine mammals from encountering potentially injurious levels of noise. Citing the example of ION Geophysical's 90-day monitoring report, the AWL points out the difficulty of monitoring these zones at distances greater than 2.2 miles. The AWL further states that the Open-water peer review panel reviewing Shell's proposed activities also noted serious limitations of visual monitoring, and quoting that ''the ability to sight animals declines with distance, and disturbance of animals beyond sighting distance may go undetected,'' and ''observations become less efficient to the point of being completely ineffective as sighting conditions deteriorate (e.g., nighttime, high sea state, precipitation or fog.'' The AWL further quotes ION's 90-day report as saying ''nights with fog, no ambient light, or heavy seas made observations nearly impossible.''

Response: NMFS recognizes the limitations of visual monitoring as distance increases. However, Shell's proposed open-water marine survey would employ a small airgun array of 40 in^3, and the modeled 180- and 190-dB exclusion zones are expected to be at 160 and 50 m from the source, respectively. Therefore, NMFS believes that at these short distances, vessel-based visual monitoring is effective. In fact, to address AWL's concern regarding the proposed mitigation measures depending on visual monitoring of the exclusion zone, the peer-review panel provided detailed analysis in its final report regarding Shell's use of vessel-based protected species observation as the primary monitoring element for the proposed marine surveys. The panel states that it ''sees this as appropriate, given the composition of the operations and expected spatial scale of influence, and finds the above objectives [ensuring disturbance to marine mammals and subsistence hunts is minimized and all permit stipulations are followed, documenting the effects of the proposed survey activities on marine mammals, and collecting baseline data on the occurrence and distribution of marine

mammals in the study area] as largely appropriate and achievable.''

In addition, 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 exclusion 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 25: Citing ION's error in its initial exclusion zone measurements, the AWL states that sound measurements used to estimate the size of safety radii from which animals should be excluded can easily be miscalculated.

Response: Although NMFS recognizes the error made by ION's contractor during the sound source verification measurement and the radius of the 180-dB exclusion was estimated less than it would be, NMFS does not agree with AWL's speculation that sound measurements used to estimate the size of exclusion zones can be ''easily miscalculated.'' The ION incident was not due to miscalculation. It was due to an human error in data handling and is preventable. NMFS has subsequently discussed this with ION and its contractor to make sure that rigorous checks and verification are performed to ensure no error in data handling.

Subsistence Issues:

Comment 26: The Commission recommends that NMFS encourage the development of a Conflict Avoidance Agreement (CAA) for Shell's proposed activities that involves all potentially affected communities and co-management organizations and that accounts for potential adverse impacts on all marine mammal species taken for subsistence purposes including, but not limited to, bowhead whales.

Response: As stated in the **Federal Register** notice for the proposed IHA, NMFS encouraged Shell to negotiate and sign a CAA to ensure that its proposed activities would not have unmitigable impacts to subsistence use of marine mammal in the proposed action area. Shell has signed the 2013 CAA, and is commended by the AEWC for engaging with AEWC in the negotiations and committing to ongoing work with the local community to ensure the protection of the subsistence traditions.

Comment 27: The AEWC expresses its concerns that Shell's Plan of Cooperation (POC) was not completed before NMFS made a preliminary determination in the **Federal Register** for the proposed IHA. The AEWC recommends that in the future the POC should be completed and submitted to NMFS along with the IHA application or that NMFS adopt and incorporate the signed CAA.

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. NMFS received a draft POC at the time from Shell while analyzing its proposed marine survey activities. However, Shell subsequently revised its proposed survey and limited its activities to only the Chukchi Sea, as opposed to both the Beaufort and Chukchi Seas as previously planned. Additional meetings were planned by Shell and the native communities to clarifying the project modification, which delayed the completion of the POC. Nevertheless, NMFS believes that it had adequate information from the draft POC to conduct the analyses and make a preliminary determination. Should a significant issue develop after the publication of the **Federal Register** notice for the proposed IHA, the final IHA would not be issued until such issues are resolved. NMFS received the final POC from Shell on June 17, 2013, describing in details the stakeholder meetings and the outcomes.

NEPA Concern:

Comment 28: AWL states that NMFS should not proceed with authorizations for individual projects like Shell's surveying until its programmatic EIS is complete. AWL supports its statement by quoting C.F.R. 1506.1(c): ''While work on a required program environmental impact statement is in progress and the action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment.''

Response: NMFS does not agree with the AWL statement. The AWL misunderstood the C.F.R. language, where it clearly states that ''agencies shall not undertake in the interim any major Federal actions covered by the program which may significantly affect the quality of the human environment,'' in which case a FONSI could not be issued. In regard to the Shell's proposed open-water marine surveys, NMFS has prepared an EA and issued a FONSI.

While the analysis contained in the Final EIS 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 in the Chukchi Sea in 2013, 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 operations.

Comment 29: The AWL states that NMFS must conduct a site-specific NEPA analysis of this action that considers meaningful alternatives. In preparing an EIS, agencies must ''rigorously explore and objectively evaluate all reasonable alternatives'' to the proposed action. Agencies must identify and assess those alternatives that would ''avoid or minimize adverse effects of [proposed] actions upon the quality of the human environment.'' The AWL further states that the discussion of alternatives ''is the heart of the [EIS],'' and the ''consideration of alternatives is critical to the goals of NEPA'' even where a proposed action does not trigger the EIS process. The AWL further states that meaningful alternatives would include a true no-action alternative that reflects that Shell cannot legally proceed in the absence of take authorization, and that NMFS should also consider alternatives that require the mitigation measures of time and/or area closures and the use of new technologies that may address some of the deficiencies in visual monitoring, and the alternatives to using the 160-dB threshold for impulse noise.

Response: 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 surveys in the Chukchi Sea during the 2013 open-water season. The EA contains detailed evaluation of all reasonable alternatives to the proposed action. The alternatives include a no-action alternative which assumes Shell, TGS, and SAE will not proceed with open-water marine and seismic surveys if take authorizations were not issued, and an additional alternative that call for the use of active acoustic monitoring and aerial surveys to supplement ship-based visual monitoring. All alternatives that would avoid or minimize adverse effects of the actions are discussed in the EA. Please

refer to NMFS EA for detailed information.

Comment 30: The AWL states that NMFS should consider cumulative impacts of other oil and gas activities and other human activities planned for the Arctic Ocean in assessing Shell's proposed surveying.

Response: NMFS prepared an EA to analyze and address cumulative impacts of other oil and gas activities planned for the Arctic Ocean. The oil and gas related activities in the U.S. Arctic in 2013 include this activity; TGS' proposed 2D seismic sruveys in the Chukchi Sea, and SAE's proposed 3D seismic survey in the Beaufort Sea. Seismic survey activities in the Canadian and Russian Arctic occur in different geophysical areas, therefore, they are not analyzed under the NMFS 2013 EA. Other appropriate factors, such as Arctic warming, military activities, and noise contributions from community and commercial activities were also considered in NMFS' 2013 EA. Please refer to that document for further discussion of cumulative impacts.

ESA Concern:

Comment 31: The AWL states that although NMFS has completed a programmatic biological opinion for Arctic oil and gas activities, it must also thoroughly analyze the impacts of the specific activities authorized here including future impacts. The AWL further states that in order to comply with the ESA, this site-specific analysis must include an incidental take statement specifying the number and type of takes expected.

Response: For the issuance of the IHA to Shell, NMFS' Permits and Conservation Division initiated consultation with NMFS Alaska Regional Office (AKRO) Protected Resources Division under section 7 of the ESA on the issuance of an IHA to Shell under section 101(a)(5)(D) of the MMPA for this activity. The consultation took into consideration the specific activities proposed to be authorized and all aspects of current and future impacts to the species. A Biological Opinion was issued on June 19, 2013, which concludes that issuance of the IHA is not likely to jeopardize the continued existence of the ESA-listed marine mammal species. In addition, analysis by NMFS AKRO showed that humpback whale will not be affected, therefore, no take was authorized. NMFS will issue 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.

Miscellaneous:

Comment 32: The BOEM states that if there have been changes to Shell's proposed activities and schedule as provided for in the proposed IHA, subsequent to their planned village meetings during May, then BOEM needs to be advised of the changes so those changes can be considered in BOEM's NEPA analysis.

Response: NMFS will coordinate with project applicants in the future to make sure BOEM is updated on any changes to the proposed activities and schedules.

Description of Marine Mammals in the Area of the Specified Activity

The marine mammal species under NMFS jurisdiction most likely to occur in the seismic survey area include nine cetacean species, beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), narwhal (*Monodon monoceros*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), minke whale (*Balaenoptera acutorostrata*), fin whale (*B. physalus*), and humpback whale (*Megaptera novaeangliae*), and four pinniped species, ringed (*Phoca hispida*), spotted (*P. largha*), bearded (*Erignathus barbatus*), and ribbon seals (*Histriophoca fasciata*).

The bowhead, fin, and humpback whales are listed as ''endangered'', and the ringed and bearded seals are listed as ''threatened'' under the Endangered Species Act (ESA) and as depleted under the MMPA. Certain stocks or populations of gray and beluga whales and spotted seals are also listed under the ESA, however, none of those stocks or populations occur in the proposed activity area.

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 2012 SAR is available at: *http://www.nmfs.noaa.gov/pr/sars/pdf/ak2012.pdf.*

Potential Effects of the Specified Activity on Marine Mammals

Operating active acoustic sources such as airgun arrays, pinger systems, and vessel activities have the potential for adverse effects on marine mammals.

Potential Effects of Airgun 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) 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 potential 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 (rms) at received level for impulse noises (such as airgun pulses) as the threshold for the onset of marine mammal behavioral harassment.

In addition, behavioral disturbance is also expressed as the change in vocal activities of animals. For example, 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 (i.e., important biological signals for marine mammals being ''masked'' by anthropogenic noise; see below). 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). Some of the changes in marine mammal vocal communication are thought to be used to compensate for acoustic masking resulting from increased anthropogenic noise (see below). 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) and intensity (Parks *et al.* 2010), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *el al.* 2000). These behavioral responses could also have adverse effects on marine mammals.

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. Therefore, it appears that behavioral disturbance can vary greatly depending on context, and not just received levels alone. 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 activity 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 (McCauley *et al.* 1998, 1999, 2000). 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. Some extreme examples including migrating bowhead whales avoiding considerably larger distances (20–30 km) and lower received sound levels (120–130 dB re 1 μPa (rms)) when exposed to airguns from seismic surveys. 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.

Odontocete: Relatively little systematic information is available about reactions of toothed whales to airgun pulses. A 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) and beluga whales (e.g., Miller *et al.* 2005). 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; 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). Marine mammal monitoring data during seismic surveys often show that animal detection rates drop during the firing of seismic airguns, indicating that animals may be avoiding the vicinity of the seismic area (Smultea *et*

al. 2004; Holst *et al.* 2006; Hauser *et al.* 2008; Holst and Smultea 2008; Richardson *et al.* 2009). 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 (Miller *et al.* 2005). In contrast, recent studies show little evidence of conspicuous reactions by sperm whales to airgun pulses, contrary to earlier indications (e.g., Gordon *et al.* 2006; Stone and Tasker 2006; Winsor and Mate 2006; Jochens *et al.* 2008), except the lower buzz (echolocation signals) rates that were detected during exposure of airgun pulses (Miller *et al.* 2009).

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 μPa (rms) distances. Stone (2003) and Stone and Tasker (2006) reported that all small odontocetes (including killer whales) observed during seismic surveys in UK waters remained significantly further from the source during periods of shooting on surveys with large volume airgun arrays than during periods without airgun shooting.

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).

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. 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.

(2) Masking

Masking occurs when noise and signals (that animal utilizes) overlap at both spectral and temporal scales. Chronic exposure to elevated sound levels could cause masking at particular frequencies for marine mammals, which utilize sound for important biological functions. Masking can interfere with detection of acoustic signals used for orientation, communication, finding prey, and avoiding predators. Marine mammals that experience severe (high intensity and extended duration) acoustic masking could potentially suffer reduced fitness, which could lead to adverse effects on survival and reproduction.

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 affect their vocal behavior (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. Average ambient noise in areas where received seismic noises are heard can be elevated. At long distances, however, the intensity of the noise is greatly reduced. Nevertheless, partial informational and energetic masking of different degrees could affect signal receiving in some marine mammals within the ensonified areas. Additional research will add to our understanding of these effects.

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).

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, and increasing call volume and vocalization rates, as discussed earlier (e.g., Miller et al. 2000; Parks *et al.* 2007; Di Iorio and Clark 2009; Parks *et al.* 2010); the biological significance of these modifications is still unknown.

(3) 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). Marine mammals that experience TTS or PTS will have reduced sensitivity at the frequency band of the TS, which may affect their capability of communication, orientation, or prey detection. The degree of TS depends on the intensity of the received levels the animal is exposed to, and the frequency at which TS occurs depends on the frequency of the received noise. It has been shown that in most cases, TS occurs at the frequencies approximately one-octave above that of the received noise. 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 μPa^2-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.

NMFS currently typically includes mitigation requirements to ensure that cetaceans and pinnipeds are not exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 μPa (rms). The 180/190 dB acoustic 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, may 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. Nevertheless, even if marine mammals were to experience TTS, the magnitude of the TTS is expected to be mild and brief, only in a few decibels for minutes.

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 widely 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 a 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 a 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 μPa ^{2}-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.

(4) 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 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.

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

Additional non-auditory effects include elevated levels of stress response (Wright *et al.* 2007; Wright and Highfill 2007). Although not many studies have been done on noise-induced stress in marine mammals, extrapolation of information regarding stress responses in other species seems applicable because the responses are highly consistent among all species in which they have been examined to date (Wright *et al.* 2007). Therefore, it is reasonable to conclude that noise acts as a stressor to marine mammals. Furthermore, given that marine mammals will likely respond in a manner consistent with other species studied, repeated and prolonged exposures to stressors (including or induced by noise) could potentially be

problematic for marine mammals of all ages. Wright *et al.* (2007) state that a range of issues may arise from an extended stress response including, but not limited to, suppression of reproduction (physiologically and behaviorally), accelerated aging and sickness-like symptoms. However, as mentioned above, Shell's proposed activity is not expected to result in these severe effects due to the nature of the potential sound exposure.

(5) Stranding and Mortality

Marine mammals close to underwater detonations 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).

It should be noted that strandings related to sound exposure have not been recorded for marine mammal species in the Chukchi or Beaufort seas. NMFS notes that in the Beaufort and Chukchi seas, aerial surveys have been conducted by BOEM (previously MMS) and industry during periods of industrial activity (and by BOEM 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. In addition, there are very few instances that seismic surveys in general have been linked to marine mammal strandings, other than those mentioned above. 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 the proposed marine survey.

Potential Effects of Sonar Signals

A variety of active acoustic instrumentation would be used during Shell's proposed marine surveys program. Source characteristics and propagation distances to 160 (rms) dB re 1 µPa by comparable instruments are listed in Table 2. In general, the potential effects of this equipment 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. In some cases, due to the fact that the operating frequencies of some of this equipment (e.g., Multi-beam bathymetric sonar: frequency at 220–240 kHz) are above the hearing ranges of marine mammals, they are not expected to have any impacts to 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 vessel and vessels used for equipment recovery and maintenance and logistic support. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002; 2005; 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007 (e.g., Aerts *et al.* 2008; Hauser *et al.* 2008; Brueggeman 2009; Ireland *et al.* 2009; O'Neill and McCrodan 2011; Chorney *et al.* 2011; McPherson and Warner 2012). 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. However, noise from the vessel during equipment recovery and maintenance while operating the DP system using thrusters as well as the primary propeller(s) could produce noise levels higher than during normal operation of the vessel. Measurements of a vessel in DP mode with an active bow thruster were made in the Chukchi Sea in 2010 (Chorney *et al.* 2011). The resulting source level estimate was 175.9 dB (rms) re 1 µPa-m. Acoustic measurements of the Nordica in DP mode while supporting Shell's 2012 drilling operation in the Chukchi Sea showed that the 120 dB re 1 µ Pa radius was at approximately 4 km (2.5 mi) (Bisson *et al.* 2013).

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. Source levels from various vessels would be empirically measured before the start of marine surveys, and during equipment recovery and maintenance while operating the DP system.

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 vessels operating in the area. However, other potential impacts to the surrounding habitat from physical disturbance are also possible.

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 non-pulse signals (such as noise from vessels) (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).

Further, during the seismic survey only a small fraction of the available habitat would be ensonified at any given time. Disturbance to fish species would be short-term and fish would return to their pre-disturbance behavior once the seismic activity ceases (McCauley *et al.* 2000a, 2000b; Santulli *et al.* 1999; Pearson *et al.* 1992). Thus, the proposed survey would have little, if any, impact on the abilities of marine mammals to feed in the area where seismic work is planned.

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). A reaction by zooplankton to a seismic impulse would only be relevant to whales if it caused concentrations of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the source. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding mysticetes. Thus, the proposed activity is not expected to have any habitat-related effects on prey species that could cause significant or long-term consequences for individual marine mammals or their populations.

Potential Impacts on Availability of Affected Species or Stock for Taking for Subsistence Uses

Subsistence hunting is an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Chukchi Sea. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60–80% of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the young, provide supplies for artistic expression, and allow for important celebratory events.

The communities closest to the project area are the villages of Wainwright and Barrow. Shell's proposed ice gouge surveys would occur offshore Wainwright but would be approximately 30 km from Barrow and 48 km from Point Lay. The closest point for Shell's proposed site clearance and shallow hazards surveys and equipment recovery and maintenance activities would be approximately 120 km to Wainwright and 150 km to Point Lay, and much farther away to Barrow.

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.''

(1) Bowhead Whales

Shell's planned surveys would have no or negligible effects on bowhead whale harvest activities. Noise and general activity associated with marine surveys and operation of vessels has the potential to harass bowhead whales. However, though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route. The proposed open-water marine surveys and vessel noise could in some circumstances affect subsistence hunts by placing the animals further offshore or otherwise at a greater distance from villages thereby increasing the difficulty of the hunt or retrieval of the harvest, or creating a safety risk to the whalers. Residents of Barrow hunt bowheads during the spring and fall migration. Although bowhead hunts by residents of Wainwright, Point Lay and Point Hope used to take place mostly in the spring and were typically curtailed when ice begins to break up, the Chukchi Sea communities increasingly are being forced to look to fall hunting opportunities as ice conditions in the spring are making it more dangerous and difficult to meet the quotas. From 1974 through 2009, bowhead harvests by these Chukchi Sea villages occurred only in the spring between early April and mid-June (Suydam and George, 2012). A Wainwright whaling crew harvested the first fall bowhead in 90 years or more on October 8, 2010, and again in October of 2011. Fall whaling by Chukchi Sea villages may occur in the future, particularly if bowhead quotas are not completely filled during the spring hunt, and fall weather is accommodating.

During the survey period most marine mammals are expected to be dispersed throughout the area, except during the peak of the bowhead whale migration through the Chukchi Seas, which occurs from late August into October. Bowhead whales are expected to be in the Canadian Beaufort Sea during much of the time, and therefore are not expected to be affected by the proposed marine surveys and vessel noise prior to the start of the fall subsistence hunt. After the conclusion of the subsistence hunt, bowheads may travel in proximity to the survey area and hear sounds from sonar, high resolution profilers, and associated vessel sounds; and may be displaced by these activities.

(2) Beluga Whales

Belugas typically do not represent a large proportion of the subsistence harvests by weight in the communities of Wainwright and Barrow, the nearest communities to Shell's planned 2013 activities in the Chukchi Sea. Barrow residents hunt beluga in the spring normally after the bowhead hunt) in leads between Point Barrow and Skull Cliffs in the Chukchi Sea primarily in April-June, and later in the summer (July-August) on both sides of the barrier island in Elson Lagoon/Beaufort Sea (MMS 2008), but harvest rates indicate the hunts are not frequent. Wainwright residents hunt beluga in April-June in the spring lead system, but this hunt typically occurs only if there are no bowheads in the area. Communal hunts for beluga are conducted along the coastal lagoon system later in July-August.

Belugas typically represent a much greater proportion of the subsistence harvest in Point Lay and Point Hope. Point Lay's primary beluga hunt occurs from mid-June through mid-July, but can sometimes continue into August if early success is not sufficient. Point Hope residents hunt beluga primarily in

the lead system during the spring (late March to early June) bowhead hunt, but also in open water along the coastline in July and August. Belugas are harvested in coastal waters near these villages, generally within a few miles from shore. The southern extent of Shell's proposed surveys is Icy Cape which lies over 30 miles (48 km) to the north of Point Lay, and therefore NMFS considers that the surveys would have no or negligible effect on beluga hunts.

The survey vessel may be resupplied via another vessel from onshore support facilities and may traverse areas that are sometimes used for subsistence hunting of belugas. Disturbance associated with vessel and potential aircraft traffic could therefore potentially affect beluga hunts. However, all of the beluga hunt by Barrow residents in the Chukchi Sea, and much of the hunt by Wainwright residents would likely be completed before Shell activities would commence.

(3) Seals

Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring before Shell's 2013 activities would commence, but some harvest continues during open water and could possibly be affected by Shell's planned activities. Spotted seals are also harvested during the summer. Most seals are harvested in coastal waters, with available maps of recent and past subsistence use areas indicating seal harvests have occurred only within 30–40 mi (48–64 km) off the coastline. Shells planned offshore surveys, equipment recovery and maintenance would occur outside state waters and are not likely to have an impact on subsistence hunting for seals. Resupply vessel and air traffic between land and the operations vessels could potentially disturb seals and, therefore, subsistence hunts for seals, but any such effects would be minor due to the small number of supporting vessels and the fact that most seal hunting is done during the winter and spring.

As stated earlier, the proposed seismic survey would take place between July and October. The closest extension of the proposed site clearance and shallow hazards surveys located approximately 120 km to Wainwright and 150 km to Point Lay, and much farther to Barrow. Potential impact from the planned activities is expected mainly from sounds generated by the vessel and during active airgun deployment. Due to the timing of the project and the distance from the surrounding communities, it is anticipated to have no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga whale, subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July—September in the Beaufort Sea), or the fall bowhead hunt.

In addition, Shell has developed and proposes to implement a number of mitigation measures which include a proposed Marine Mammal Monitoring and Mitigation Plan (4MP), employment of subsistence advisors in the villages, and implementation of a Communications Plan (with operation of Communication Centers). Shell has prepared a Plan of Cooperation (POC) under 50 CFR 216.104 Article 12 of the MMPA to address potential impacts on subsistent seal hunting activities. Shell met with the Alaska Eskimo Whaling Commission (AEWC) and communities' Whaling Captains' Associations as part of the POC development, to establish avoidance guidelines and other mitigation measures to be followed where the proposed activities may have an impact on subsistence.

Finally, to ensure that there will be no conflict from Shell's proposed open-water marine surveys and equipment recovery and maintenance to subsistence activities, Shell signed a Conflict Avoidance Agreement with the local subsistence communities. The CAA identifies what measures have been or will be taken to minimize adverse impacts of the planned activities on subsistence harvesting.

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 the Shell open-water marine surveys and equipment recovery and maintenance activities in the Chukchi Sea, NMFS is requiring Shell to implement the following mitigation measures to minimize the potential impacts to marine mammals in the project vicinity as a result of its survey activities. The primary purpose of these mitigation measures is to detect marine mammals within, or about to enter designated exclusion zones and to initiate immediate shutdown or power down of the airgun(s).

(1) Establishing Exclusion and Disturbance Zones

Under current NMFS guidelines, the ''exclusion zone'' for marine mammal exposure to impulse sources is customarily defined as the area within which received sound levels are ≥180 dB (rms) re 1 μPa for cetaceans and ≥190 dB (rms) re 1 μPa 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 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 exclusion zones (Richarcdson *et al.* 1995). Currently, NMFS uses 160 dB (rms) re 1 μPa as the threshold for Level B behavioral harassment from impulses noise, and 120 dB (rms) re 1 μPa for Level B behavioral harassment from non-impulse noise.

Exclusion and disturbance radii for the sound levels produced by the 40 in ^{3} array and the single mitigation airgun (10 cubic inches) to be used during the 2013 site clearance and shallow hazards survey activities were measured at the Honeyguide and Burger prospect areas a total of three separate times between 2008 and 2009. The largest radii from these measurements will be implemented at the commencement of 2013 airgun operations to establish marine mammal exclusion zones used for mitigation (Table 3). Shell will conduct sound source measurements of the airgun array at the beginning of survey operations in 2013 to verify the size of the various marine mammal exclusion zones (see above). The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify and adjust the marine mammal exclusion zone distances. The mitigation measures to be implemented at the 190 and 180 dB (rms) sound levels will include power downs and shut downs as described below.

TABLE 3—DISTANCES OF THE 190 AND 180 dB (rms) RE 1 μPa ISOLPETHS (IN M) TO BE USED FOR MITIGATION PURPOSES AT THE BEGINNING OF 2013 AIRGUN OPERATIONS IN THE CHUKCHI SEAL UNTIL SSV RESULTS ARE AVAILABLE.

Received levels (dB re 1 μPa rms)	4-Airgun array (40 in^3)	Single airgun (10 in^3)
190	50	23
180	160	52

(2) Vessel and Helicopter Related Mitigation Measures,

This mitigation measure applies to all vessels that are part of the Chukchi Sea marine surveys and equipment recovery and maintenance activities, including crew transfer vessels.

- Avoid concentrations or groups of whales by all vessels under the direction of Shell. Operators of support vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.
- Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:
  - Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);
  - Steering around the whale(s) if possible;
  - Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;
  - Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and
  - Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.
- When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.
- In the event that any aircraft (such as helicopters) are used to support the planned survey, the mitigation measures below would apply:
  - Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level (ASL) when within 0.3 mile (0.5 km) of groups of whales.
  - Helicopters shall not hover or circle above or within 0.3 mile (0.5 km) of groups of whales.

(3) Mitigation Measures for Airgun Operations

The primary role for airgun mitigation during the site clearance and shallow hazards surveys is to monitor marine mammals near the airgun array during all daylight airgun operations and during any nighttime start-up of the airguns. During the site clearance and shallow hazards surveys PSOs will monitor the pre-established exclusion zones for the presence of marine mammals. When marine mammals are observed within, or about to enter, designated exclusion zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations as required by the situation. A summary of the procedures associated with each mitigation measure is provided below.

Ramp Up Procedure

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise 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 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 (i.e., the mitigation airgun). A full ramp up, after a shut down, will not begin until there has been a minimum of 30 min of observation of the exclusion zone by PSOs to assure that no marine mammals are present. The entire exclusion zone must be visible during the 30-minute lead-in to a full ramp up. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the exclusion 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 exclusion zone or the animal(s) is not sighted for at least 15–30 minutes: 15 minutes for small odontocetes (harbor porpoise) and pinnipeds, or 30 minutes for baleen whales and large odontocetes (including beluga and killer whales and narwhal).

Use of a Small-Volume Airgun During Turns and Transits

Throughout the seismic survey, particularly during turning movements, and short transits, Shell will employ the use of a small-volume airgun (i.e., 10 in^3 ''mitigation airgun'') to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the proposed project).

During turns or brief transits (e.g., less than three hours) between seismic tracklines, one mitigation airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. 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, site clearance and shallow hazards surveys using the full array may resume without the 30 minute observation period of the full exclusion zone required for a ''cold start''. PSOs will be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

Power-Down and Shut Down Procedures

A power down is the immediate reduction in the number of operating energy sources from all firing to some smaller number (e.g., single mitigation airgun). A shut down is the immediate cessation of firing of all energy sources. The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation source. If a marine mammal is sighted within or about to enter the applicable

exclusion zone of the single mitigation airgun, the entire array will be shut down (i.e., no sources firing).

In addition, site clearance and shallow hazard surveys will not commence or will shut down if an aggregation of 12 or more bowhead whales or gray whales that appear to be engaged in a non-migratory, significant biological behavior (e.g., feeding, socializing) are observed during vessel monitoring within the 160-dB zone of disturbance.

Poor Visibility Conditions

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

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

(4) Mitigation Measures for Subsistence Activities

Regulations at 50 CFR 216.104(a)(12) require IHA applicants for activities that take place in Arctic waters to provide a Plan of Cooperation (POC) or information that identifies what measures have been taken and/or will be taken to minimize adverse effects on the availability of marine mammals for subsistence purposes.

Shell has prepared a POC, which relies upon the Chukchi Sea Communication Plans to identify the measures that Shell has developed in consultation with North Slope subsistence communities and will implement during its planned 2013 activities to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC provides detailed Shell's communications and consultations with local subsistence communities concerning its planned 2013 program, potential conflicts with subsistence activities, and means of resolving any such conflicts.

The POC is 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 typically included in updates attached to the POC as addenda and 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 2013 drilling and open-water marine surveys programs in the Beaufort and Chukchi Seas occurred in Kaktovik, Nuiqsut Barrow, Wainwright, and Point Lay, during October of 2012. Shell met with the marine mammal commissions and committees including the Alaska Eskimo Whaling Commission (AEWC), Eskimo Walrus Commission (EWC), Alaska Beluga Whale Committee (ABWC), Alaska Ice Seal Committee (AISC), and the Alaska Nanuuq Commission (ANC) on December 17 and 18, 2012 in a co-management meeting. In March 2013, Shell revised its 2013 program to suspend plans for drilling, delete the proposed geotechnical program entirely, and remove survey activities from the Beaufort Sea. As a result, Shell has revised the proposed open-water marine surveys program for 2013, thereby necessitating the additional community meetings that were held this spring in Chukchi Sea villages to present changes to the 2013 season. Shell conducted these POC meetings in Chukchi Sea villages May 20–29, 2013. Shell submitted a final POC to NMFS on June 17, 2013.

Following the 2013 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.

In addition, Shell signed the 2013 Conflict Avoidance Agreement (CAA) with the Alaska subsistence whaling communities to ensure no unmitigable impacts to subsistence whaling from its proposed open-water marine survey activities in the Chukchi Sea.

Mitigation Conclusions

NMFS has carefully evaluated these mitigation measures and considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another:

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

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has 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.

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 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.

I. Monitoring Measures

Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished in the Chukchi Sea during 2013 by conducting vessel-based monitoring from all ships with sound sources and an acoustic monitoring program to document underwater sounds and the vocalizations of marine mammals in the region. The following monitoring measures are required for Shell's 2013 open-water marine surveys in the Chukchi Sea.

Visual monitoring by Protected Species Observers (PSOs) during active marine survey operations, and periods when these surveys are not occurring, will provide information on the numbers of marine mammals potentially affected by these activities and facilitate real time mitigation to prevent impacts to marine mammals by industrial sounds or operations. Vessel-based PSOs onboard the survey vessel will record the numbers and species of marine mammals observed in the area and any observable reaction of marine mammals to the survey activities in the Chukchi Sea. Additionally, monitoring by PSOs aboard the vessel utilized for equipment recovery and maintenance activities at the Burger A well site will ensure that there are no interactions between marine mammals and these operations. PSOs aboard the vessel will monitor adjacent areas while the vessel operates from a stationary position in DP mode.

The acoustics monitoring program will characterize the sounds produced by marine surveys and will document the potential reactions of marine mammals in the area to those sounds and activities. Recordings of ambient sound levels and vocalizations of marine mammals along the Chukchi Sea coast and offshore will also be used to interpret potential impacts to marine mammals around the marine survey and equipment recovery and maintenance activity, in addition to subsistence use areas closer to shore. Although these monitoring programs were designed primarily to understand the impacts of exploratory drilling in the Chukchi Sea they will also provide valuable information about the potential impacts of the 2013 marine surveys on marine mammals in the area.

Visual-Based Protected Species Observers (PSOs)

The visual-based marine mammal monitoring will be implemented by a team of experienced PSOs, including both biologists and Inupiat personnel. PSOs will be stationed aboard the marine survey vessel and the vessel used to facilitate equipment recovery and maintenance work at the Burger A exploratory well site through the duration of the projects. The vessel-based marine mammal monitoring will provide the basis for real-time mitigation measures as discussed in the Mitigation Measures section. In addition, monitoring results of the vessel-based monitoring program will include the estimation of the number of ''takes'' as stipulated in the IHA.

(1) Protected Species Observers

Vessel-based monitoring for marine mammals will be done by trained PSOs throughout the period of survey activities. The observers will monitor the occurrence of marine mammals near the survey vessel during all daylight periods during operation, and during most daylight periods when operations are not occurring. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting ''take by harassment''.

A sufficient number of PSOs will be required onboard the survey vessel to meet the following criteria:

- 100% monitoring coverage during all periods of survey operations in daylight;
- maximum of 4 consecutive hours on watch per PSO; and
- maximum of ~12 hours of watch time per day per PSO.

PSO teams will consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the PSO team onboard the survey vessel. The total number of PSOs may decrease later in the season as the duration of daylight decreases.

(2) Observer Qualifications and Training

Crew leaders and most PSOs will be individuals with experience as observers during recent seismic, site clearance and shallow hazards, and other monitoring projects in Alaska 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 and familiar with the marine mammals of the area. All observers will 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 PSOs (see below).

PSOs will complete a two or three-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2013 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.

(3) PSO Handbook

A PSO's Handbook will be prepared for Shell's 2013 vessel-based monitoring program. Handbooks contain maps, illustrations, and photographs, as well as text, and are intended to provide guidance and reference information to trained individuals who will participate as PSOs. The following topics will be covered in the PSO Handbook for the Shell project:

- Summary overview descriptions of the project, marine mammals and underwater noise, the marine mammal monitoring program (vessel roles, responsibilities), and the Marine Mammal Protection Act;
- Monitoring and mitigation objectives and procedures, including radii for exclusion zones;
- Responsibilities of staff and crew regarding the marine mammal monitoring plan;
- Instructions for ship crew regarding the marine mammal monitoring plan;
- Data recording procedures: codes and coding instructions, PSO coding mistakes, electronic database; navigational, marine physical, field data sheet;
- List of species that might be encountered: identification, natural history;
- Use of specialized field equipment (reticle binoculars, NVDs, etc.);
- Reticle binocular distance scale;
- Table of wind speed, Beaufort wind force, and sea state codes; and
- Data quality-assurance/quality-control, delivery, storage, and backup procedures.

Marine Mammal Observer Protocol

The PSOs will watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge. The PSOs will scan systematically with the unaided eye and 7 x 50 reticle binoculars, supplemented with 20 x 60 image-stabilized Zeiss Binoculars or Fujinon 25 x 150 ''Big-eye'' binoculars, and night-vision equipment when needed. Personnel on the bridge will assist the marine mammal observer(s) in watching for marine mammals.

PSOs aboard the stationary vessel used to conduct equipment recovery and maintenance activity will focus their attention on areas immediately adjacent to the vessel and where active operations are occurring to ensure these areas are clear of marine mammals and

that there are no direct interactions between animals and equipment or project personnel. The observer(s) aboard the marine survey vessel will give particular attention to the areas within the marine mammal exclusion zones around the source vessel. These zones are the maximum distances within which received levels may exceed 180 dB (rms) re 1 μPa (rms) for cetaceans, or 190 dB (rms) re 1 μPa for other marine mammals. Information to be recorded by PSOs 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; Reiser *et al.* 2010, 2011). When a mammal sighting is made, the following information about the sighting will be recorded:

- Species, group size, age/size/sex categories, behavior when first sighted and after initial sighting, heading, bearing and distance from observer, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and pace.
- Time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare.
- The positions of other vessel(s) in the vicinity of the observer location.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.

When a marine mammal is seen approaching or within the exclusion zone applicable to that species, the marine survey crew will be notified immediately so that mitigation measures called for in the applicable authorization(s) can be implemented.

Night-vision equipment (Generation 3 binocular image intensifiers or equivalent units) will be available for use when/if needed. Past experience with night-vision devices (NVDs) in the Chukchi Sea and elsewhere has indicated that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Field Data-Recording, Verification, Handling, and Security

PSOs will record their observations directly into computers running a custom designed software package. Paper datasheets will be available as backup if necessary. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be sent off of the ship to Anchorage each day (if possible) and backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

Passive Acoustic Monitoring

(1) Sound Source Measurements

The objectives of the sound source measurements planned for 2013 will be (1) to measure the distances at which broadband received levels reach 190, 180, 170, 160, and 120 dB (rms) re 1 μPa during marine surveys and equipment recovery and maintenance activity at the Burger A exploratory well site, and from vessels used during these activities. The measurements of airguns and other marine survey equipment will be made by an acoustics contractor at the beginning of the surveys. Data from survey equipment will be previewed in the field immediately after download from the hydrophone instruments. An initial sound source analysis will be supplied to NMFS and the vessel within 120 hours of completion of the measurements, if possible. The report will indicate the distances to sound levels based on fits of empirical transmission loss formulae to data in the endfire and broadside directions. A more detailed report will be provided to NMFS as part of the 90-day report following completion of the acoustic program.

(2) Long-Term Acoustic Monitoring

Acoustic studies that were undertaken from 2006 through 2012 in the Chukchi Sea as part of the Joint Monitoring Program will be continued by Shell during its proposed open-water marine survey and equipment recovery and maintenance activity in 2013. The acoustic ''net'' array used during the 2006–2012 field seasons in the Chukchi Sea was designed to accomplish two main objectives. The first was to collect information on the occurrence and distribution of marine mammals (including beluga whale, bowhead whale, walrus and other species) that may be available to subsistence hunters near villages located on the Chukchi Sea coast and to document their relative abundance, habitat use, and migratory patterns. The second objective was to measure the ambient soundscape throughout the eastern Chukchi Sea and to record received levels of sounds from industry and other activities further offshore in the Chukchi Sea.

The basic components of this effort consist of autonomous acoustic recorders deployed widely across the US Chukchi Sea through the open water season and then the winter season. These precisely calibrated systems will sample at 16 kHz with 24-bit resolution, and are capable of recording marine mammal sounds and making anthropogenic noise measurements. The net array configuration will include a regional array of 24 Autonomous Multichannel Acoustic Recorders (AMAR) deployed July-October off the four main transect locations: Cape Lisburne, Point Hope, Wainwright and Barrow. These will be augmented by six AMARs deployed August 2013–August 2014 at Hanna Shoal. Six additional AMAR recorders will be deployed in a hexagonal geometry at 16 km from the nominal Burger A exploratory well location to monitor directional variations of equipment recovery/maintenance and support vessel sounds in addition to examining marine mammal vocalization patterns in the vicinity of these activities. One new recorder will be placed 32 km northwest of the Burger A well site to monitor for sound propagation toward the south side of Hanna Shoal, which acoustic and satellite tag monitoring has identified as frequented by walrus in August. Marine survey activities will occur in areas within the coverage of the net array. All of these offshore systems will capture marine survey and equipment recovery/maintenance sounds, where present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. They will continue to provide a large amount of information related to marine mammal distributions in the Chukchi Sea.

In early October, all of the regional recorders will be retrieved except for the six Hanna Shoal recorders, which will continue to record on a duty cycle until August 2014. An additional set of nine Aural winter recorders will be deployed at the same time at the same locations that were instrumented in winter 2012–2013. These recorders will sample at 16

kHz on a 17% duty cycle (40 minutes every 4 hours). The winter recorders deployed in previous years have provided important information about bowhead, beluga, walrus and several seal species migrations in fall and spring.

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 mitigation and monitoring plan in its IHA application for taking marine mammals incidental to the proposed open-water marine surveys and equipment recovery and maintenance in the Chukchi Sea during 2013. The panel met on January 8 and 9, 2013, and provided their final report to NMFS on March 5, 2013. 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 monitoring and mitigation plan and asked the panel to address the following questions and issues for Shell's plan:

- Will the applicant's stated objectives effectively further the understanding of the impacts of their activities on marine mammals and otherwise accomplish the goals stated below? If not, how should the objectives be modified to better accomplish the goals above?
- Can the applicant achieve the stated objectives based on the methods described in the plan?
- Are there technical modifications to the proposed monitoring techniques and methodologies proposed by the applicant that should be considered to better accomplish their stated objectives?
- Are there techniques not proposed by the applicant (i.e., additional monitoring techniques or methodologies) that should be considered for inclusion in the applicant's monitoring program to better accomplish their stated objectives?
- What is the best way for an applicant to present their data and results (formatting, metrics, graphics, etc.) in the required reports that are to be submitted to NMFS (i.e., 90-day report and comprehensive report)?

The peer review panel report contains recommendations that the panel members felt were applicable to the Shell's monitoring plans. Overall the panel feels that the proposed methods for visual monitoring are adequate and appropriate as the primary means of assessing the acute near-field impacts of the proposed marine surveys. The panel also cautions that there should be realistic expectations regarding the limitations of these surveys to provide scientific-level measurements of distribution and density, but in terms of meeting the monitoring requirements, the panel finds the proposed methods adequate and appreciate the improvements and modifications (e.g., in terms of PSO training, field data collection methods) made over the past few years. Nevertheless, the panel also provides several recommendations concerning improving night-time monitoring, passive acoustic monitoring, and data analysis and presentation.

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 2013 open-water marine surveys and equipment recovery and maintenance program. 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 2013 open-water season due to time constrains for this season. 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 2013 open-water marine surveys and equipment recovery and maintenance program by Shell (and incorporates into the IHA) and, separately, those that are recommended for future programs.

Included in the 2013 Monitoring Plan

The peer review panel's report contains several recommendations regarding visual monitoring during low-visibility and presentation of data in reports, which NMFS agrees that Shell should incorporate and included in the IHA:

(1) Visual monitoring during low-visibility

- Shell should use the best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other instruments that incorporate infrared technology; presently the efficacy of these technologies appears limited but the panel and NMFS encourage continued consideration of their applicability as it continues to evolve.

(2) Data analysis and presentation

- Shell should apply appropriate statistical procedures for probability estimation of marine mammals missed, based on observational data acquired during some period of time before and after night or fog events.
- Shell should provide useful summaries and interpretations of results of the various elements of the monitoring results. A clear timeline and spatial (map) representation/summary of operations and important observations should be given. Any and all mitigation measures (e.g., vessel course deviations for animal avoidance, operational shut down) should be summarized. Additionally, an assessment of the efficacy of monitoring methods should be provided.

In addition to these recommendations, Shell also agrees to produce a weekly GIS application that would be available on the web for regulators to view for every observation and mitigation measure implemented.

Recommendations to be Partially Implemented or Considered for Future Monitoring Plans

In addition, the panelists recommended that:

- Shell should integrate the acoustic information from the net array to the greatest extent possible to assess the aggregate known activities, at least those from Shell operations but more broadly as possible, to assess patterns of marine mammal vocal activities and how that might be used to investigate potentially broader impacts from overlapping/interacting activities.
- Shell should consider integration of visual and acoustic data from the Chukchi monitoring program and the Joint Monitoring Program to produce estimates of bowhead, beluga, and walrus density using methods developed in the Density Estimation for Cetacean from Passive Acoustic Fixed Sensors (DECAF) project by the Center

for Research into Ecological and Environmental Modeling (CREEM) at the University of St. Andrews in Scotland.

After discussion with Shell, NMFS decided not to implement these two recommendations in full during Shell's 2013 open-water marine surveys and equipment recovery and maintenance program because the systematic and comprehensive analyses of these acoustic datasets would require far more time and effort than what would be needed to assess marine mammal takes under the MMPA. However, Shell agrees that it will provide data from net arrays supported in part, or in whole, by Shell and will participate in the integration of acoustic arrays to assess the sound field of the lease areas in the Chukchi and Beaufort seas for the purposes of assessing patterns of marine mammal distribution and behavior and for assessing the impacts of multiple activities/factors. In addition, Shell will evaluate the potential of the DECAF project and efforts will be made to assess the applicability of the data collection infrastructure established in the Shell monitoring program to these and similar studies.

II. Reporting Measures

Sound Source Verification Reports

A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, 160, and 120 dB (rms) radii of the airgun sources, will be submitted within 14 days after collection of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the survey.

Field Reports

Throughout the survey program, PSOs will prepare a report each day or at such other intervals, summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS and to the survey operators.

Technical Reports

The results of Shell's 2013 vessel-based monitoring, including estimates of ''take'' by harassment, will be presented in the ''90-day'' and Final Technical reports. The Technical Reports should be submitted to NMFS within 90 days after the end of the seismic survey. 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) To better assess impacts to marine mammals, data analysis should be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:

- Data for periods when a seismic array is active and when it is not; and
- The respective predicted received sound conditions over fairly large areas (tens of km) around operations;

(e) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as:

- Initial sighting distances versus airgun activity state;
- closest point of approach versus airgun activity state;
- observed behaviors and types of movements versus airgun activity state;
- numbers of sightings/individuals seen versus airgun activity state;
- distribution around the survey vessel versus airgun activity state; and
- estimates of take by harassment;

(f) Reported results from all hypothesis tests should include estimates of the associated statistical power when practicable;

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

(h) The report should clearly compare authorized takes to the level of actual estimated takes; and

Notification of Injured or Dead Marine Mammals

In addition, NMFS would require Shell to 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 shall 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 would report the same information as listed above as soon as operationally feasible to NMFS.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]. Only take by Level B behavioral harassment is anticipated as a result of the proposed open water marine survey program. Anticipated impacts to marine mammals are associated with noise propagation from the survey airgun(s) used in the shallow hazards survey.

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: 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) is highly unlikely to occur based on the required mitigation and monitoring measures that would preclude marine mammals from being exposed to noise levels high enough to cause hearing impairment.

For impulse sounds, such as those produced by airgun(s) used in the site clearance and shallow hazards surveys, NMFS uses the 160 dB (rms) re 1 μPa isopleth to indicate the onset of Level B harassment. For non-impulse sounds, such as those produced by vessel's DP thrusters during the proposed

equipment recovery and maintenance program, NMFS uses the 120 dB (rms) re 1 μPa isopleth to indicate the onset of Level B harassment. Shell provided calculations for both the 160- and 120-dB isopleths produced by these activities and then used those isopleths to estimate takes by harassment. NMFS used the calculations to make the necessary MMPA findings. Shell provided a full description of the methodology used to estimate takes by harassment in its IHA application, which is also provided in the following sections.

Basis for Estimating ''Take by Harassment''

The estimated takes by harassment is calculated in this section by multiplying the expected densities of marine mammals that may occur near the planned activities by the area of water likely to be exposed to impulse sound levels of ≥160 dB (rms) re 1 μPa and non-impulse sound levels ≥120 dB (rms) re 1 μPa.

Marine mammal occurrence near the operation is likely to vary by season and habitat, mostly related to the presence or absence of sea ice. Although current NMFS' noise exposure standards state that Level B harassment occurs at exposure levels ≥160 dB (rms) re 1 μPa by impulse sources and exposure levels ≥120 dB (rms) re 1 μPa by non-impulse sources, there is no evidence that avoidance at these received sound levels would have significant biological effects on individual animals. Any changes in behavior caused by sounds at or near the specified received levels would likely fall within the normal variation in such activities that would occur in the absence of the planned operations. However, these received levels are currently used to set the threshold for Level B behavioral harassment.

Marine Mammal Density Estimates

Marine mammal density estimates in the Chukchi Sea have been derived for two time periods, the summer period covering July and August, and the fall period including September and October. Animal densities encountered in the Chukchi Sea during both of these time periods will further depend on the habitat zone within which the operations are occurring: open water or ice margin. Vessel and equipment limitations will result in very little activity occurring in or near sea ice; however, if ice is present near the areas of activity some sounds produced by the activities may remain above disturbance threshold levels in ice margin habitats. Therefore, open water densities have been used to estimate potential ''take by harassment'' in 90 percent of the area expected to be ensonified above disturbance thresholds while ice margin densities have been used in the remaining 10 percent of the ensonified area.

For a few marine mammal species, several density estimates were available. In those cases, the mean and maximum estimates were determined from the reported densities or survey data. In other cases, no applicable estimate was available, so correction factors were used to arrive density estimates. These are described in detail in the following sections.

Detectability bias, quantified in part by f(0), is associated with diminishing sightability with increasing lateral distance from the survey trackline. Availability bias, g(0), refers to the fact that there is <100 percent probability of sighting an animal that is present along the survey trackline.

Nine cetacean and four pinniped species under NMFS jurisdiction are known to occur in the planned project area in the Chukchi Sea. Five of them (bowhead, fin, and humpback whales, and ringed and bearded seals) are listed as ''endangered'' or ''threatened'' under the ESA.

(1) Beluga Whale

Summer densities of belugas in offshore waters are expected to be low, with somewhat higher densities in ice-margin and nearshore areas. Aerial surveys have recorded few belugas in the offshore Chukchi Sea during the summer months (Moore *et al.* 2000). Aerial surveys of the Chukchi Sea in 2008–2009 flown by the National Marine Mammal Laboratory (NMML) as part of the Chukchi Offshore Monitoring in Drilling Area (COMIDA) project have only reported 5 beluga sightings during >8,700 mi (>14,000 km) of on-transect effort, only 2 of which were offshore (COMIDA 2009). One of the three nearshore sightings was of a large group (~275 individuals on July 12, 2009) of migrating belugas along the coastline just north of Peard Bay. Additionally, only one beluga sighting was recorded during >49,710 mi (>80,000 km) of visual effort during good visibility conditions from industry vessels operating in the Chukchi Sea in September–October of 2006–2010 (Hartin *et al.* 2011). If belugas are present during the summer, they are more likely to occur in or near the ice edge or close to shore during their northward migration. Expected densities have previously been calculated from data in Moore *et al.* (2000). However, more recent data from COMIDA aerial surveys during 2008–2010 are now available (Clarke and Ferguson in prep.). Effort and sightings reported by Clarke and Ferguson (in prep.) were used to calculate the average open-water density estimate. Clarke and Ferguson (in prep) reported two on-transect beluga sightings (5 individuals) during 11,985 km of on-transect effort in waters 36–50 m deep in the Chukchi Sea during July and August. The mean group size of these two sightings is 2.5. A f(0) value of 2.841 and g(0) value of 0.58 from Harwood *et al.* (1996) were also used in the density calculation. Specific data on the relative abundance of beluga in open-water versus ice-margin habitat during the summer in the Chukchi Sea is not available. However, belugas are commonly associated with ice, so an inflation factor of 4 was used to estimate the average ice-margin density from the open-water density. Very low densities observed from vessels operating in the Chukchi Sea during non-seismic periods and locations in July-August of 2006–2010 (0.0–0.0003/mi^2, 0.0–0.0001/km2; Hartin *et al.* 2011), also suggest the number of beluga whales likely to be present near the planned activities will not be large.

In the fall, beluga whale densities offshore in the Chukchi Sea are expected to be somewhat higher than in the summer because individuals of the eastern Chukchi Sea stock and the Beaufort Sea stock will be migrating south to their wintering grounds in the Bering Sea (Allen and Angliss 2012). Densities derived from survey results in the northern Chukchi Sea in Clarke and Ferguson (in prep) were used as the average density for open-water fall season estimates. Clarke and Ferguson (in prep) reported 3 beluga sightings (6 individuals) during 10,036 km of on-transect effort in water depths 36–50 m. The mean group size of those three sightings is 2. A f(0) value of 2.841 and g(0) value of 0.58 from Harwood *et al.* (1996) were used in the calculation. Moore *et al.* (2000) reported lower than expected beluga sighting rates in open-water during fall surveys in the Beaufort and Chukchi seas, so an inflation value of 4 was used to estimate the average ice-margin density from the open-water density. Based on the few beluga sightings from vessels operating in the Chukchi Sea during non-seismic periods and locations in September-November of 2006–2010 (Hartin *et al.* 2011), the relatively low densities are consistent with what is likely to be observed from vessels during the planned operations.

(2) Bowhead Whale

By July, most bowhead whales are northeast of the Chukchi Sea, within or

migrating toward their summer feeding grounds in the eastern Beaufort Sea. No bowheads were reported during 6,640 mi (10,686 km) of on-transect effort in the Chukchi Sea by Moore *et al.* (2000). Aerial surveys in 2008–2010 by the NMML as part of the COMIDA project reported only 6 sightings during >16,020 mi (>25,781 km) of on-transect effort (Clarke and Ferguson in prep). Two of the six sightings were in waters ≤35 m deep and the remaining four sightings were in waters 51–200 m deep. Bowhead whales were also rarely sighted in July–August of 2006–2010 during aerial surveys of the Chukchi Sea coast (Thomas *et al.* 2011). This is consistent with movements of tagged whales, all of which moved through the Chukchi Sea by early May 2009, and tended to travel relatively close to shore, especially in the northern Chukchi Sea. The estimate of bowhead whale density in the Chukchi Sea was calculated by assuming there was one bowhead sighting during the 7,447 mi (11,985 km) of survey effort in waters 36–50 m deep in the Chukchi Sea during July–August reported in Clarke and Ferguson (in prep), although no bowheads were actually observed during those surveys. The mean group size from September–October sightings reported in Clarke and Ferguson (in prep) is 1.1, and this was also used in the calculation of summer densities. The group size value, along with a f(0) value of 2 and a g(0) value of 0.07, both from Thomas *et al.* (2002) were used to estimate a summer density of bowhead whales. Bowheads are not expected to be encountered in higher densities near ice in the summer (Moore *et al.* 2000), so the same density estimates are used for open-water and ice-margin habitats. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July–August of 2006–2010 (Hartin *et al.* 2011) ranged from 0.0005–0.0021/mi² (0.0002–0.0008/km²).

During the fall, bowhead whales that summered in the Beaufort Sea and Amundsen Gulf migrate west and south to their wintering grounds in the Bering Sea making it more likely that bowheads will be encountered in the Chukchi Sea at this time of year. Moore *et al.* (2000) reported 34 bowhead sightings during 27,560 mi (44,354 km) of on-transect survey effort in the Chukchi Sea during September–October. Thomas *et al.* (2011) also reported increased sightings on coastal surveys of the Chukchi Sea during October and November of 2006–2010. GPS tagging of bowheads appear to show that migration routes through Chukchi Sea are more variable than through the Beaufort Sea (Quakenbush *et al.* 2010). Some of the routes taken by bowheads remain well north of the planned marine survey activities while others have passed near to or through the area. Kernel densities estimated from GPS locations of whales suggest that bowheads do not spend much time (e.g., feeding or resting) in the north-central Chukchi Sea near the area of planned activities (Quakenbush *et al.* 2010). Clarke and Ferguson (in prep) reported 14 sightings (15 individuals) during 10,036 km of on transect aerial survey effort in 2008–2010. The mean group size of those sightings is 1.1. The same f(0) and g(0) values that were used for the summer estimates above were used for the fall estimates. Moore *et al.* (2000) found that bowheads were detected more often than expected in association with ice in the Chukchi Sea in September–October, so a density of twice the average open-water density was used as the average ice-margin density. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in September–November of 2006–2010 (Hartin et al. 2011) ranged from 0.0008 to 0.0135/mi² (0.0003–0.0052/km²). This suggests the densities used in the calculations are somewhat higher than are likely to be observed from vessels near the areas of planned operations.

(3) Gray Whale

Gray whale densities are expected to be much higher in the summer months than during the fall. Moore *et al.* (2000) found the distribution of gray whales in the planned operational area was scattered and limited to nearshore areas where most whales were observed in water less than 114 ft (35 m) deep. Thomas *et al.* (2011) also reported substantial declines in the sighting rates of gray whales in the fall. The average open-water summer density was calculated from 2008–2010 aerial survey effort and sightings in Clarke and Ferguson (in prep) for water depths 118–164 ft (36–50 m) including 54 sightings (73 individuals) during 7,447 mi (11,985 km) of on-transect effort. The average group size of those sightings is 1.35. Correction factors f(0) = 2.49 (Forney and Barlow 1998) and g(0) = 0.30 (Forney and Barlow 1998, Mallonee 1991) were also used in the density calculation. Gray whales are not commonly associated with sea ice, but may be present near it, so the same densities were used for ice-margin habitat as were derived for open-water habitat during both seasons. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July–August of 2006–2010 (Hartin *et al.* 2011) ranged from 0.0021/mi² to 0.0221/mi² (0.0008/km² to 0.0085/km²).

In the fall, gray whales may be dispersed more widely through the northern Chukchi Sea (Moore *et al.* 2000), but overall densities are likely to be decreasing as the whales begin migrating south. A density calculated from effort and sightings (15 sightings [19 individuals] during 6,236 mi (10,036 km) of on-transect effort) in water 118–164 ft (36–50 m) deep during September–October reported by Clarke and Ferguson (in prep) was used as the average estimate for the Chukchi Sea during the fall period. The corresponding group size value of 1.26, along with the same f(0) and g(0) values described above were used in the calculation. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in September-November of 2006–2010 (Hartin *et al.* 2011) ranged from 0.0/mi² to 0.0114/mi² (0.0/km² to 0.0044/km²).

(4) Harbor Porpoise

Harbor Porpoise densities were estimated from industry data collected during 2006–2010 activities in the Chukchi Sea. Prior to 2006, no reliable estimates were available for the Chukchi Sea and harbor porpoise presence was expected to be very low and limited to nearshore regions. Observers on industry vessels in 2006–2010, however, recorded sightings throughout the Chukchi Sea during the summer and early fall months. Density estimates from 2006–2010 observations during non-seismic periods and locations in July-August ranged from 0.0034/mi² to 0.0075/mi² (0.0013/km² to 0.0029/km²) (Hartin *et al.* 2011). The average density from the summer season of those three years (0.0057/mi², 0.0022/km²) was used as the average open-water density estimate. Harbor porpoise are not expected to be present in higher numbers near ice, so the open-water densities were used for ice-margin habitat in both seasons. Harbor porpoise densities recorded during industry operations in the fall months of 2006–2010 were slightly lower and ranged from 0.0/mi² to 0.0114/mi² (0.0/km² to 0.0044/km²). The average of those years (0.0055/mi², 0.0021/km²) was again used as the average density estimate.

(5) Other Cetaceans

The remaining five cetacean species that could be encountered in the Chukchi Sea during Shell's planned marine survey program include the humpback whale, killer whale, minke whale, fin whale, and narwhal. Although there is evidence of the occasional occurrence of these animals

in the Chukchi Sea, it is unlikely that more than a few individuals will be encountered during the planned marine survey activities. Clarke *et al.* (2011b) and Hartin *et al.* (2011) reported humpback whale sightings; George and Suydam (1998) reported killer whales; Brueggeman *et al.* (1990), Hartin *et al.* (2011) and COMIDA (2011) reported minke whales; and Clarke *et al.* (2011b) and Hartin *et al.* (2011) reported fin whales. Narwhal sightings in the Chukchi Sea have not been reported in recent literature, but subsistence hunters occasionally report observations near Barrow, and Reeves *et al.* (2002) indicated a small number of extralimital sightings in the Chukchi Sea.

(6) Ringed and Bearded Seals

Ringed seal and bearded seals summer ice-margin densities were available in Bengtson *et al.* (2005) from spring surveys in the offshore pack ice zone of the northern Chukchi Sea. However, corrections for bearded seal availability, g(0), based on haulout and diving patterns were not available. Densities of ringed and bearded seals in open water are expected to be somewhat lower in the summer when preferred pack ice habitat may still be present in the Chukchi Sea. Average and maximum open-water densities have been estimated at ¾ of the ice margin densities during both seasons for both species. The fall density of ringed seals in the offshore Chukchi Sea has been estimated as ⅔ the summer densities because ringed seals begin to reoccupy nearshore fast ice areas as it forms in the fall. Bearded seals may also begin to leave the Chukchi Sea in the fall, but less is known about their movement patterns so fall densities were left unchanged from summer densities. For comparison, the ringed seal density estimates calculated from data collected during summer 2006–2010 industry operations ranged from 0.0359/mi^2 to 0.1206/mi^2 (0.0138/km^2 to 0.0464/km^2) (Hartin *et al.* 2011). These estimates are lower than those made by Bengtson *et al.* (2005) which is not surprising given the different survey methods and timing.

(7) Spotted Seal

Little information on spotted seal densities in offshore areas of the Chukchi Sea is available. Spotted seal densities in the summer were estimated by multiplying the ringed seal densities by 0.02. This was based on the ratio of the estimated Chukchi populations of the two species. Chukchi Sea spotted seal abundance was estimated by assuming that 8 percent of the Alaskan population of spotted seals is present in the Chukchi Sea during the summer and fall (Rugh *et al.* 1997), the Alaskan population of spotted seals is 59,214 (Allen and Angliss 2012), and that the population of ringed seals in the Alaskan Chukchi Sea is ~208,000 animals (Bengtson *et al.* 2005). In the fall, spotted seals show increased use of coastal haulouts so densities were estimated to be ⅔ of the summer densities.

(8) Ribbon Seals

Four ribbon seal sightings were reported during industry vessel operations in the Chukchi Sea in 2006–2010 (Hartin *et al.* 2011). The resulting density estimate of 0.0013/mi^2 (0.0007/km^2) was used for both seasons and habitat zones.

Area Potentially Exposed to Sound Levels Above 160 dB During Site Clearance and Shallow Hazards Surveys

As described earlier, Shell's proposed site clearance and shallow hazards surveys would occur in three survey areas of the Chukchi Sea Lease Area. These three survey areas are the Burger prospect (Survey Area 2), Crackerjack prospect (Survey Area 1), and an area northeast of Burger (Survey Area 3; Figure 1–2 of the IHA application). The precise survey sites within the survey areas at these prospects have not yet been determined, but there are five notional locations at Burger, three at Crackerjack, and one northeast of Burger. The five potential survey sites at Burger range in size from 23 km^2 to 40 km^2 (9 mi^2 to 15 mi^2) while the three potential sites at Crackerjack range from 35 km^2 to 119 km^2 (14 mi^2 to 46 mi^2). The single site northeast of Burger may be ~119 km^2 (46 mi^2).

Shell plans to use the same 4 x 10 in^3 airgun configuration that was used during site clearance and shallow hazards surveys in the Chukchi Sea in 2008 and 2009. Measurements during these two years occurred at three locations: Honeyguide (west of the Crackerjack prospect), Crackerjack, and Burger. The measurements showed that the Burger site had the largest radius from the source to the 160 dB (rms) re 1 µPa isopleths at 1,800 m. As a cautionary approach, the Burger site distance (1,800 m from the source) plus a 25 percent inflation factor (equaling 2,250 m) was used to estimate the total area that may be ensonified to 160 dB (rms) re 1 µPa by seismic sounds at all of the potential survey sites at any given time, which equals to 15.9 km^2.

Shell's operations plan calls for site clearance and shallow hazards surveys to begin at the Burger prospect. Adding the 2.25 km 160 dB (rms) radius to the perimeter of all five of the notional survey grids at that site results in a total area at Burger of 477 km^2 being exposed to seismic sound ≥160 dB (rms). This is approximately 40 percent of the total area that may be exposed to seismic sounds during the survey activities and it has been attributed to the July–August period. Adding the 2.25 km 160 dB (rms) radius to the perimeter of the three notional survey areas at Crackerjack and the one northeast of Burger results in a total area of 826 km^2 being potentially exposed to pulsed seismic sounds ≥160 dB (rms). Since these areas would likely be surveyed after the Burger sites are completed they have been attributed to the September–October period. The total area potentially exposed is then 1,303 km^2 (477 km^2 + 826 km^2).

Area Potentially Exposed to Sound Levels Above 120 dB During Equipment Recovery and Maintenance Program

As described earlier, Shell's proposed equipment recovery and maintenance at the Burger A well site where drilling took place in 2012 would involve a vessel engaging with DP thrusters while remotely operated vehicles or divers are used to perform the required work. Sounds produced by the vessel while in dynamic positioning mode will be non-impulse in nature and are thus evaluated at the ≥120 dB (rms) level.

The vessel from which equipment recovery and maintenance will be conducted has not yet been determined. Various sound measurements were conducted from vessels during DP operations and during drilling activities (which may include DP operations) in the Chukchi Sea in the past two years. Under most circumstances, sounds from dynamic positioning thrusters are expected to be well below 120 dB (rms) at distances greater than 10 km (6 mi). Among those measurements, the drilling activities conducted by the *Tor Viking II* at the Burger A well site in 2012 may have included dynamic positioning, and its distance of 13 km (8 mi) was selected to model the 120 dB (rms) re 1 µPa isopleths for Shell's proposed 2013 equipment recovery and maintenance program. This yields to a 120 dB (rms) re 1 µPa ensonified zone of approximately 531 km^2 (205 mi^2).

The equipment recovery and maintenance work at the well site may occur during either or both of the seasonal periods and may take place over as many as 28 days. Therefore, the entire area potentially exposed to continuous sounds ≥120 dB (rms) from dynamic positioning thrusters has been applied to densities of marine mammals during both seasonal periods.

Potential Number of ''Take by Harassment''

As stated earlier, the estimates of potential Level B takes of marine mammals by noise exposure are based on a consideration of the number of marine mammals that might be present during operations in the Chukchi Sea and the anticipated area exposed to those sound pressure levels (SPLs) above 160 dB re 1 μPa for impulse sources (seismic aregun during site clearance and shallow hazards surveys) and SPLs above 120 dB re 1 μPa for non-impulse sources (vessel's DP operation during equipment recovery and maintenance program).

The number of individuals of each species potentially exposed to received levels was estimated by multiplying the anticipated area to be ensonified to the specified SPLs in each season (summer and fall) and habitat zone (open water and ice margin) to which a density applies, by the expected species density. The numbers of individuals potentially exposed were then summed for each species across the two seasons and habitat zones.

An additional calculation was made that assumes the entire population of marine mammals within the 531 km^2 (205 mi^2) area exposed to non-pulsed sounds ≥120 dB (rms) re 1 μPa during the equipment recovery and maintenance activity is different every day during that 28 day period. To do this, the 28 days were split evenly between the July–August and September–October periods (14 days in each period). The area ensonified by continuous sounds on each day was then multiplied by 14 before being multiplied by the appropriate species density within each season.

Some of the animals estimated to be exposed, particularly migrating bowhead whales, might show avoidance reactions before being exposed to sounds at the specified threshold levels. Thus, these calculations actually estimate the number of individuals potentially exposed to the specified sounds levels that would occur if there were no avoidance of the area ensonified to that level.

As described above, vessel and equipment limitations will result in very little activity occurring in or near sea ice; however, if ice is present near the areas of activity, some sounds produced by the activities may remain above disturbance threshold levels in ice margin habitats. Therefore, open water densities have been used to estimate potential ''take by harassment'' in 90 percent of the area expected to be ensonified above disturbance thresholds while ice margin densities have been used in the remaining 10 percent of the ensonified area. Species with an estimated average number of individuals exposed equal to zero are included below for completeness, but are not likely to be encountered.

Numbers of marine mammals that might be present and potentially taken are summarized in Table 4 based on calculation described above.

Some of the animals estimated to be exposed, particularly migrating bowhead whales, might show avoidance reactions before being exposed to ≥160 dB (rms) re 1 μPa. Thus, these calculations actually estimate the number of individuals potentially exposed to specific SPLs, i.e., ≥160 dB (rms) re 1 μPa for impulse noise and ≥120 dB (rms) re 1 μPa for non-impulse noise, that would occur if there were no avoidance of the area ensonified to that level.

Because beluga whales may form groups, additional takes were added on top of the density-based take calculation in the event a large group is encountered during the survey. For marine mammal species that are rare and for which no density estimates are available in the vicinity of the proposed project area (such as humpback, fin, minke, and killer whales and narwhal), a small number of takes have been requested in case they are encountered (Table 4).

TABLE 4—ESTIMATES OF THE POSSIBLE MAXIMUM NUMBERS OF MARINE MAMMALS TAKEN BY LEVEL B HARASSMENT (EXPOSED TO ≥160 dB FROM AIRGUN SOUND AND ≥120 dB FROM DYNAMIC POSITIONING OPERATIONS) DURING SHELL'S PROPOSED MARINE SURVEY AND EQUIPMENT RECOVERY AND MAINTENANCE ACTIVITY IN THE CHUKCHI SEA, JULY—OCTOBER 2013, INCLUDING A DAILY MULTIPLIER FOR THE ENTIRE 28 DAYS OPERATIONAL PERIOD AT THE BURGER A WELL SITE

Species	Level B takes	Percent population
Bowhead whale	209	1.98
Gray whale	270	1.41
Fin whale	10	0.18
Humpback whale	10	1.07
Minke whale	10	1.23
Beluga whale*	53	1.43
Narwhal	4	NA
Killer whale	10	3.18
Harbor porpoise	35	0.07
Ringed seal	5,096	2.44
Bearded seal	178	0.07
Spotted seal	102	0.17
Ribbon seal	12	0.02

* Additional takes were added in the event that a large group of beluga whales is encountered.

Estimated Take Conclusions

Effects on marine mammals are generally expected to be restricted to avoidance of the area around the planned activities and short-term changes in behavior, falling within the MMPA definition of ''Level B harassment''.

Cetaceans—The average estimates without a daily multiplier for the stationary operations suggest a total of 209 bowhead whales may be exposed to sounds at or above the specified levels. This number is approximately 1.98% of the BCB population of 10,545 assessed in 2001 (Allen and Angliss 2011) and is assuming to be increasing at an annual growth rate of 3.4% (Zeh and Punt 2005), which is supported by a 2004 population estimate of 12,631 by Koski et al. (2010). Including a daily multiplier brings the average estimate up to 209 individual bowhead whales with the daily multiplier (Table 4). The total estimated number of gray whales that may be exposed to sounds from the activities ranges up to 270 with the daily multiplier (Table 4). Fewer beluga whales and harbor porpoises are likely to be exposed to sounds during the activities. The small numbers of other whale species that may occur in the Chukchi Sea are unlikely to be present around the planned operations but chance encounters may occur. The few individuals would represent a very small proportion of their respective populations.

Pinnipeds—Ringed seal is by far the most abundant species expected to be encountered during the planned operations. The best estimate of the numbers of ringed seals exposed to sounds at the specified received levels during the planned activities is 727 not including a daily multiplier, and 5,096 if a daily multiplier is included. Both of these numbers represent <3 percent of the estimated Alaska population. Fewer individuals of other pinniped species are estimated to be exposed to sounds at the specified received levels, also representing small proportions of their populations. Pinnipeds are unlikely to react to non-impulse sounds until received levels are much stronger than 120 dB (rms), so it is probable that a smaller number of these animals would actually be appreciably disturbed.

Negligible Impact and Small Numbers Analysis and Determination

As a preliminary matter, we typically include our negligible impact and small numbers analyses and determinations under the same section heading of our **Federal Register** Notices. Despite co-locating these terms, we acknowledge

that negligible impact and small numbers are distinct standards under the MMPA and treat them as such. The analyses presented below do not conflate the two standards; instead, each standard has been considered independently and we have applied the relevant factors to inform our negligible impact and small numbers determinations.

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 2013 marine surveys and equipment recovery and maintenance program in the Chukchi Sea, and none are authorized. The proposed site clearance and shallow hazards surveys would use a very small 40 in^3 airgun array, which have much less acoustic power outputs compared to conventional airgun arrays with displacement volume in the range of thousands of cubic inches. The modeled isopleths at 180 dB, based on prior measurements for the same airgun array in the vicinity of the 2013 survey sites, is expected to be 160 m from the source at maximum. Source levels from vessel's DP thrusters during Shell's proposed equipment recovery and maintenance program are below 180 dB re 1 μPa.

In addition, animals in the area are not expected to incur hearing impairment (i.e., TTS or PTS) or non-auditory physiological effects. The modeled isopleths at 160 dB and 120 dB, based on prior measurements, are expected to be approximately 1.8 km and 13km from the airgun array and DP-operating vessel, respectively. 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 the proposed site clearance and shallow hazard surveys and equipment recovery and maintenance activities more than once, the expanse of these multi-exposures are expected to be less extensive since either the animals or the vessels conducting the marine surveys will be moving constantly in and out of the survey areas.

Most of the bowhead whales encountered will likely show overt disturbance (avoidance) only if they receive airgun sounds with levels ≥ 160 dB re 1 μPa. Odontocete reactions to seismic airgun pulses are usually assumed to be limited to shorter distances from the airgun(s) than are those of mysticetes, probably in part because odontocete low-frequency hearing is assumed to be less sensitive than that of mysticetes. However, at least when in the Canadian Beaufort Sea in summer, belugas appear to be fairly responsive to seismic energy, with few being sighted within 6–12 mi (10–20 km) of seismic vessels during aerial surveys (Miller *et al.* 2005). Belugas will likely occur in small numbers in the Chukchi Sea during the survey period and few will likely be affected by the survey activity.

Although the stationary nature of the vessel that conducts equipment recovery and maintenance could affect different individuals of marine mammals during the operations, the relatively short period (28 days) of this activity precludes the take of large numbers of marine mammals. In addition, the noise levels generated from DP thrusters are much lower than the levels from the airgun array, and the modeled 120 dB isopleths is expected to be 13 km at the maximum, resulting an ensonified area of 531 km^2.

Taking into account the mitigation measures that are planned, effects on marine mammals are generally expected to be restricted to avoidance of a limited area around Shell's proposed open-water activities and short-term changes in behavior, falling within the MMPA definition of ''Level B harassment''. The many reported cases of apparent tolerance by cetaceans of seismic exploration, vessel traffic, and some other human activities show that co-existence is possible. Mitigation measures such as controlled vessel speed, dedicated marine mammal observers, non-pursuit, and shut downs or power downs when marine mammals are seen within defined ranges will further reduce short-term reactions and minimize any effects on hearing sensitivity. In all cases, the effects are expected to be short-term, with no lasting biological consequence.

Of the thirteen marine mammal species likely to occur in the proposed marine survey area, bowhead, fin, and humpback whales and ringed and bearded seals are listed as endangered or threatened under the ESA. These 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 fin and 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, fin, and humpback whales. The Alaska stock of bearded seals, part of the Beringia distinct population segment (DPS), and the Arctic stock of ringed seals, have recently been listed by NMFS as threatened under the ESA. None of the other 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 authorized take represents 1.43% of the Eastern Chukchi Sea population of approximately 3,710 beluga whales, 3.18% of Aleutian Island and Bering Sea stock of approximately 314 killer whales, 0.07% of Bering Sea stock of approximately 48,215 harbor porpoises, 1.41% of the Eastern North Pacific stock of approximately 19,126 gray whales, 1.98% of the Bering-Chukchi-Beaufort population of 10,545 bowhead whales, 1.07% of the Western North Pacific stock of approximately 938 humpback whales, 0.18% of the Northeast Pacific stock of approximately 5,700 fin whales, and 1.43% of the Alaska stock of approximately 810 minke whales. The take estimates presented for ringed, bearded, spotted, and ribbon seals represent 2.44, 0.07, 0.17, and 0.02% of U.S. Arctic stocks of each species, respectively. The percentage of Level B behavioral take of 4 individual narwhals among its population is unknown as narwhal are not regularly sighted in the U.S. Chukchi Sea. Nevertheless, it is reasonable to believe that the number of narwhal estimated to be taken is a very

low percentage of its population. The mitigation and monitoring measures (described previously in this document) required under the IHA (if issued) are expected to reduce even further any potential disturbance to marine mammals.

In addition, no important feeding and reproductive areas are known in the vicinity of the Shell's proposed marine surveys at the time the proposed surveys are to take place. No critical habitat of ESA-listed marine mammal species occurs in the Chukchi Sea.

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 2013 open-water marine surveys in the Chukchi Sea 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 2013 open-water marine surveys in the Chukchi Sea 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 Chukchi Sea open-water marine surveys that should minimize impacts to subsistence hunters. Due to the timing of the project and the distance from the surrounding communities (the proposed site clearance and shallow hazards surveys and equipment recovery and maintenance activities would be approximately 120 km to Wainwright and 150 km to Point Lay), it is anticipated to have no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga whale, subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July-September in the Beaufort Sea), or the fall bowhead hunt.

Endangered Species Act (ESA)

The bowhead, fin, and humpback whales and ringed and bearded seals are the only marine mammal species currently listed as endangered or threatened under the ESA that could occur during Shell's proposed marine surveys during the Arctic open-water season. NMFS' Permits and Conservation 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 June 19, 2013, which concludes that issuance of the IHA is not likely to jeopardize the continued existence of the ESA-listed marine mammal species. NMFS will issue 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 surveys in the Chukchi Sea during the 2013 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 2013 marine survey in the Chukchi Sea, Alaska, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: July 30, 2013.

Donna S. Wieting,

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

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