DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XC091

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

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

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

SUMMARY: NMFS received an application from ION Geophysical (ION) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment only, incidental to a proposed marine seismic survey in the Beaufort and Chukchi Seas, Alaska, between October and December 2012. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to ION to take, by harassment, nine species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than September 17, 2012.

ADDRESSES: Comments on the application should be addressed to Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is *itp.guan@noaa.gov.* NMFS is not responsible for email comments sent to addresses other than the one provided here. Comments sent via email, including all attachments, must not exceed a 25-megabyte file size.

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

An electronic copy of the application used in this document may be obtained by writing to the address specified above, telephoning the contact listed below (see **FOR FURTHER INFORMATION CONTACT**), or visiting the internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.* The following associated document is also available at the same internet address: Draft Plan of Cooperation. Documents cited in this notice may also 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.

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.

An 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 a one-year authorization to incidentally take small numbers of marine mammals by harassment, provided that there is no potential for serious injury or mortality to result from the activity. 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 March 1, 2012, from ION for the taking, by harassment, of marine mammals incidental to a marine seismic survey in ice in the Beaufort and Chukchi Seas, Alaska, during October through December 2012. After addressing comments from NMFS, ION modified its application and submitted a revised application on June 11, 2012. The June 11, 2012, application is the one available for public comment (see **ADDRESSES**) and considered by NMFS for this proposed IHA. ION also submitted IHA applications for essentially the same in-ice seismic survey activity in 2010 and 2011. However, in both years ION withdrew its applications due to logistical issues in carrying out such activities before NMFS published a notice of proposed IHA and request for public comments. Take by Level B harassment only of nine species of marine mammals is anticipated to result from the specified activity. ION has also requested authorization for Level A harassment of a few individuals of bowhead whale, beluga whale, and ringed seal.

Description of the Specified Activity

ION's proposed activities consist of a geophysical in-ice (seismic reflection/refraction) survey and related vessel operations to be conducted primarily in the Alaskan Beaufort and Chukchi seas from October to December 2012. The primary survey area extends from the U.S.–Canadian border in the east to Point Barrow in the west. Two survey lines extend west of Point Barrow into the northern Chukchi Sea, and three short tie lines are proposed near the U.S.–Russian border (see Figure 1 of ION's IHA application). The bathymetry of the proposed survey area ranges from shallow (<20 m [66 ft]) to relatively deep (≤3,500 m [11,483 ft]) water over the continental shelf, the continental slope, and the abyssal plain.

The survey would be conducted from the seismic vessel *Geo Arctic* escorted by the *Polar Prince,* a medium class (100A) icebreaker. The survey grid consists of ~7,175 km (4,458 mi) of transect line, not including transits when the airguns are not operating. There may be small amounts of additional seismic operations associated with airgun testing, start up, and repeat coverage of any areas where initial data quality is sub-standard. The seismic source towed by the *Geo Arctic* would be an airgun array consisting of 26 active Sercel G-gun airguns with a total volume of 4,450 in^3. A single hydrophone streamer 4.5–9 km (2.8–5.6 mi) in length, depending on ice conditions, would be towed by the *Geo Arctic* to record the returning seismic signals.

The survey vessels would access the survey area from Canadian waters in late September to begin data collection on or after October 1, 2012. After completion of the survey, or when ice and weather conditions dictate, the vessels would exit to the south, transiting through the Chukchi and Bering Seas. The *Polar Prince* may be used to perform an at-sea refueling (bunkering) operation to supply as much as 500 metric tons of Arctic diesel to the *Geo Arctic.* The *Polar Prince* would carry that fuel onboard at the start of the operation, and it would be transferred to the *Geo Arctic* if/when necessary. Depending on its own fuel consumption, the *Polar Prince* may then transit to Tuktoyuktuk, Canada to take on additional fuel for itself. Once the *Polar Prince* returns to the *Geo Arctic* the survey would continue. The entire refueling operation would therefore involve one fuel transfer and potentially one transit to and from Tuktoyuktuk. The refueling operation would likely take place in late October, at which time the *Geo Arctic* would likely be in the eastern or east-central Alaskan Beaufort Sea.

ION's geophysical survey has been designed and scheduled to minimize potential effects to marine mammals, bowhead whales in particular, and subsistence users. For mitigation and operational reasons, the survey area has been bisected by a line that runs from 70.5° N. 150.5° W. to 73° N. 148° W. (see Figure 1 of ION's IHA application). Weather and ice permitting, ION plans to begin survey operations east of the line described above (eastern survey area) and in offshore waters (>1,000 m [3,281 ft]) where bowheads are expected to be least abundant in early October. This operational plan is based on the fact that only ~2% of bowhead whales observed by Bureau of Ocean Energy Management's (BOEM) aerial surveys from 1979–2007 occurred in areas of water depth >1,000 m (3,281 ft) (MMS, 2010), and on average ~97% of bowheads have passed through the eastern U.S. Beaufort Sea by October 15 (Miller *et al.,* 2002). The survey would then progress to shallower waters in the eastern survey area before moving to the western survey area in late October or early November 2012.

Ice conditions are expected to range from open water to 10/10 ice cover. However, the survey cannot take place in thick multi-year ice as both the icebreaker and seismic vessel must make continuous forward progress at 3–4 kts. In order for the survey to proceed, areas of high ice concentration can only consist of mostly newly forming juvenile first year ice or young first year ice less than 0.5 m (1.6 ft) thick. Sounds generated by the icebreaker and seismic vessel moving through these relatively light ice conditions are expected to be far below the high sound levels often attributed to icebreaking. These high sound levels (>200 dB re 1 μPa [rms]) have been recorded from icebreakers during backing and ramming operations in very heavy ice conditions and are created by cavitation of the propellers as the vessel is slowed by the ice or reverses direction (Erbe and Farmer, 1998; Roth and Schmidt, 2010).

Acoustic Sources

(1) Seismic Airgun Array

The seismic source used during the project would be an airgun array consisting of 28 Sercel G-gun airguns, of which 26 would be active and have a total discharge volume of 4,450 in^3. The 28 airguns would be distributed in two sub-arrays with 14 airguns per sub-array. Individual airgun sizes range from 70 to 380 in^3. Airguns would be operated at 2,000 psi. The seismic array and a single hydrophone streamer 4.5–9 km (2.8–5.6 mi) in length would be towed behind the *Geo Arctic.* Additional specifications of the airgun array are provided in Appendix B of ION's IHA application.

(2) Echo Sounders

Both vessels would operate industry standard echo sounder/fathometer instruments for continuous measurements of water depth while underway. These instruments are used by all large vessels to provide routine water depth information to the vessel crew. Navigation echo sounders send a single, narrowly focused, high frequency acoustic signal directly downward to the sea floor. The sound energy reflected off the sea floor returns to the vessel where it is detected by the instrument, and the depth is calculated and displayed to the user. Source levels of navigational echo sounders of this type are typically in the 180–200 dB re 1 μPA-m (Richardson *et al.,* 1995a).

The *Geo Arctic* would use one navigational echo sounder during the project. The downward facing single-beam Simrad EA600 operates at frequencies ranging from 38 to 200 kHz with an output power of 100–2000 Watts. Pulse durations are between 0.064 and 4.096 milliseconds, and the pulse repetition frequency (PRF or ping rate) depends on the depth range. The highest PRF at shallow depths is about 40 pings per second. It can be used for water depths up to 4,000 m (13,123 ft) and provides up to 1 cm (0.4 in) resolution.

The *Polar Prince* would use one echo sounder, an ELAC LAZ–72. The LAZ–72 has an operating frequency of 30 kHz. The ping rate depends on the water depth and the fastest rate, which occurs in shallow depths, is about 5 pings per second.

Dates, Duration, and Region of Activity

The proposed geophysical survey would be conducted for ~76 days from approximately October 1 to December 15, 2012. Both the *Geo Arctic* and the *Polar Prince* would leave from Tuktoyaktuk, Canada, during late September and enter the Alaskan Beaufort Sea from Canadian waters. The survey area would be bounded approximately by 138° to 169° W. longitude and 70° to 73° N. latitude in water depths ranging from <20 to >3,500 m (66 to 11,483 ft) (see Figure 1 of ION's IHA application). For mitigation and operational reasons the survey area has been bisected by a line that runs from 70.5° N, 150.5° W to 73° N, 148° W. Weather and ice permitting, ION plans to begin survey operations east of the line (eastern survey area) in offshore waters (>1,000 m [3,281 ft]) where bowheads are expected to be least abundant in early October. The survey would then progress to shallower waters in the eastern survey area before moving to the west survey area in late October or early November. The vessels would depart the region to the south via the Chukchi and Bering Seas and arrive in Dutch Harbor in mid- to late December.

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 two cetacean species, beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*), and two pinniped species, ringed (*Phoca hispida*) and bearded (*Erignathus barbatus*) seals. It is possible that some bowhead whales may be encountered as they migrate out of the area, particularly in the portion of the survey area where water depths are <200 m (656 ft). Beluga whales are most likely to be encountered farther offshore than bowheads.

The ringed seal is the most abundant marine mammal in the proposed survey area. Although bearded seals typically migrate south in the fall, it is possible that small numbers of them may be present in the survey area. Most other marine mammal species have typically migrated south into the Chukchi and Bering Seas by the time this survey will take place. The polar bear is managed by the U.S. Fish and Wildlife Service (USFWS) and is not considered further in this proposed IHA notice.

Seven additional cetacean species have known occurrences within the proposed project area and some may occur in the area during the time of the proposed in-ice seismic survey: harbor porpoise (*Phocoena phocoena*); gray whale (*Eschrichtius robustus*); humpback whale (*Megaptera novaeangliae*); fin whale (*Balaenoptera physalus*); minke whale (*B. acutorostrata*); killer whale (*Orcinus orca*); and narwhal (*Monodon monoceros*). The gray whale occurs regularly in continental shelf waters along the Chukchi Sea coast in summer and to a lesser extent along the Beaufort Sea coast. Recent evidence from monitoring activities in the Chukchi and Beaufort Seas during industry seismic surveys suggests that the harbor porpoise and minke whale, which have been considered uncommon or rare in the Chukchi and Beaufort Seas, may be increasing in numbers in these areas (Funk *et al.,* 2010). Additional pinniped species under NMFS jurisdiction that could be encountered during the proposed geophysical in-ice survey include spotted (*P. largha*) and ribbon seals (*Histriophoca fasciata*). Spotted seals are more abundant in the Chukchi Sea and occur in small numbers in the Beaufort Sea. The ribbon seal is uncommon in the Chukchi Sea, and there are few reported sightings in the Beaufort Sea.

Small numbers of killer whales have also been recorded during recent industry surveys, along with a few sightings of fin and humpback whales. The narwhal occurs in Canadian waters and occasionally in the Beaufort Sea but is rare there and not expected to be encountered. Each of these species (killer, fin, and humpback whales and narwhal) is uncommon or rare in the Beaufort Sea, particularly during early winter, and relatively few if any encounters with these species are expected during the time period of the proposed seismic program.

The bowhead, humpback, and fin whales are listed as ''endangered'' 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 listed as endangered or proposed for listing under the ESA; however, none of those stocks or populations occur in the proposed activity area. Additionally, the ribbon seal is considered a ''species of concern'', meaning that NMFS has some concerns regarding status and threats of this species, but for which insufficient information is available to indicate a need to list the species under the ESA. On December 10, 2010, NMFS published a notice of proposed threatened status for subspecies of the ringed seal (75 FR 77476) and a notice of proposed threatened and not warranted status for subspecies and distinct population segments of the bearded seal (75 FR 77496) in the **Federal Register**. Neither of these two ice seal species is considered depleted under the MMPA.

Based on the occurrence of marine mammal species in the proposed project area and the time of year in which the survey is proposed to be conducted, NMFS is proposing to authorize take by harassment for the following species: Beluga, bowhead, gray, and minke whales; harbor porpoise; and ringed, bearded, spotted, and ribbon seals.

ION'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 2011 SAR is available at: *http://www.nmfs.noaa.gov/pr/pdfs/sars/ak2011.pdf.*

Potential Effects of the Specified Activity on Marine Mammals

Operating active acoustic sources such as an airgun array, echo sounders, and icebreaking activities could potentially affect 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, at least in theory, 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 when exposed to anthropogenic sound. These behavioral reactions are often shown as: changing durations of surfacing and dives; changing number of blows per surfacing; 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 behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. While many behavioral responses would not be expected to likely affect the fitness of an individual, other more severe behavioral modifications, especially in certain circumstances, could potentially have adverse affects on growth, survival, and/or reproduction. Some more potentially significant behavioral modifications include: drastic change in diving/surfacing patterns (such as those thought to be potentially associated with beaked whale stranding due to exposure to military mid-frequency tactical sonar) or longer-term habitat abandonment.

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 sound, which is difficult to predict, depends on both external factors (*e.g.,* characteristics of sound sources and their paths) and the receiving animals (hearing, motivation, experience, demography) (Southall *et al.* 2007).

Currently NMFS uses 160 dB re 1 μPa (rms) received level for impulse noises (such as airgun pulses) as the threshold for the onset of Level B (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 sound; 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). Researchers have noted 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 (2.5–9.3 mi) 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 include migrating bowhead whales avoiding considerably larger distances (20–30 km [12.4–18.6 mi]) at 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 rates 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 during that same time period (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: Little systematic information is available about reactions of toothed whales to airgun pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above have been reported for toothed whales. However, there are recent systematic data on sperm whales (*e.g.,* Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009). There is also an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (*e.g.,* Stone, 2003; Smultea *et al.,* 2004; Moulton and Miller, 2005; 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 (6.2–12.4 mi) from operating seismic vessels. 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, available data suggest that individuals may not react until sounds are ≥170 dB re 1 μPa (rms). With a medium-to-large airgun array, received levels typically diminish to 170 dB within 1–4 km (0.62–2.5 mi), 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 at 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 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 pinnipeds may not move away, or 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 is the obscuring of sounds of interest by other sounds, often at similar frequencies. Chronic exposure to excessive, though not high-intensity, noise could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Since marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that experience severe (intensity and duration) acoustic masking could potentially suffer some adverse effects.

Masking occurs when noise and signals (that animal utilizes) overlap at both spectral and temporal scales. For the airgun noise generated from the proposed in-ice 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 sound 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 (*e.g.,* bowhead and gray whales) 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 is needed to further address 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 inconsequential 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 and would certainly depend on the duration of the masking event, the behavioral state of the animal, and the overall context of the exposure.

(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 sound. It has been shown that in most cases, TS occurs at the frequencies approximately one-octave above that of the received sound. Repeated sound 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 truncatus*) 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 sound exposure levels (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.* (2010a, 2010b) also support the notion that exposure duration has a more significant influence compared to sound pressure level (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 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 enough level for a sufficiently long enough 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 could be exposed to strong sound pulses, possibly repeatedly.

If some cetaceans did incur mild or moderate TTS (a Level B harassment) 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 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 180 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 180 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 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 non-impulse 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 a sufficiently long enough period to incur PTS. There is some concern about bow-riding 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. NMFS considers PTS to be a Level A harassment.

(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 ION's proposed in-ice seismic surveys given the brief duration of exposure 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, ION'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 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 deem the issue to warrant 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 Beaufort Sea. NMFS notes that in the Beaufort Sea, aerial surveys have been conducted by the Minerals Management Service (now BOEM) 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 seismic survey.

Potential Effects From Echo Sounders on Marine Mammals

Three types of echo sounders have been proposed for ION's 2012 in-ice seismic survey in the Beaufort and Chukchi Seas. In general, the potential effects of this equipment on marine mammals can be expected to be similar to those from the airgun, except that the sounds from these sources are at much higher frequencies than those from airguns, and thus may have more potential to affect mid- and high-frequency hearing odontocetes and pinnipeds than mysticetes, who are thought to be more sensitive to low-frequency sounds. Therefore, it is possible that the onset of hearing impairment to odontocetes and pinnipeds that are exposed to mid- or high-frequency sources could be lower, or the growth of TTS and/or PTS could be faster than the earlier empirical measurements using the watergun source (Finneran *et al.,* 2002) or 3 kHz tones (Finneran *et al.,* 2005). However, the magnitude of the impacts is expected to be less due to the lower intensity of the sound from echo sounders when compared to seismic airguns. Because of the higher frequencies of the echo sounder signals, the propagation ranges of acoustic signals are also much shorter than those from the airgun array. Since these echo sounders will be operating during the seismic survey, no additional takes of marine mammals would be considered as take estimates would be calculated from ensonified zones from seismic airguns. In addition, due to the fact that the operating frequencies of some of this equipment (*e.g.,* Skipper GDS102 that operates at frequencies above 200 kHz) are above the hearing ranges of marine mammals, use of the equipment is not expected to cause any take of marine mammals. Furthermore, the beam patterns of the echo sounders are directed downward and are narrow, so any marine mammals that encounter the echo sounders at close range are unlikely to be subjected to repeated pulses.

Potential Effects From Icebreaking on Marine Mammals

(1) Noise Source Levels From Icebreaking

Most sounds generated by icebreaking activities are caused by cavitation of the propellers. Propeller cavitation and resulting sounds tend to be greatest when a vessel is moving astern or when its forward progress has been stopped by heavy ice during ramming. When making continuous forward progress through ice, more power is required than when traveling through open water. The greater the resistance, the greater the propeller cavitation and resulting sounds, although they are typically less strong during continuous forward progress than during backing and ramming in heavy ice.

Measurements of the *Robert Lemur* pushing and breaking ice in the Beaufort Sea in 1986 resulted in an estimated broadband source level of 193 dB re 1 μPa @ 1 m (Richardson *et al.,* 1995). Ice conditions were not described in detail, but at that time of year (in September), ice is not typically forming, so the ice pans that were encountered were likely composed of second year ice or multi-year ice.

The broadband source levels of three different vessels pushing on or breaking ice during drilling activities in the U.S. Beaufort Sea in 1993 were 181–183, 184, and 174 dB re 1 μPa @ 1 m (Hall *et al.,* 1994). Similar to the above, ice conditions in mid-August when these recordings were made were likely to have been thick first year (sea ice does not reach ''second year'' status until September 1), second year, or multi-year ice.

The strongest sounds produced by an icebreaker backing and ramming an ice ridge were measured at 203 dB re 1 μPa @ 1 m at the point when the propellers were still turning at full speed ahead, but the vessel had come to a stop when it failed to break the ice ridge (Erbe and Farmer, 1998). A similar maximum source level (200 dB re 1 μPa @ 1m) was reported during backing and ramming activities by the U.S. Coast Guard Cutter *Healy* as measured by a sonobuoy deployed from that vessel in 2009 (Roth and Schmidt, 2010).

Roth and Schmidt (2010) describe three very recent ''case studies'' of *Healy* breaking ice in the high Arctic. Ice type is not described, but given the date, location, and pictures provided the ice is clearly not first year ice and instead likely second year or multi-year ice. The first case study provides an example of the *Healy* traveling through 7–9/10ths ice and then entering open-water. Average source levels in ice were estimated to be ~185 dB while average source levels in open-water were estimated between 175–180 dB. The second case study is an example of backing and ramming in 8/10ths ice. Maximum source levels reached 191–195 dB. The third case study is another example of backing and ramming, this time in 9/10ths ice, where maximum source levels reached 200 dB.

None of these examples apply very well to ice conditions likely to be encountered during ION's proposed October-December survey. The ice regimes to be encountered along the Alaskan Coast in the proposed survey area during the proposed survey period will vary considerably from predominantly or entirely open water in early October to being predominantly new, first year ice in November. The survey work will take advantage of such variations to complete the more difficult lines when the ice conditions are favorable for that work.

This project will involve two ships working as one when in or near sea ice. In this mode, the icebreaker (*Polar Prince*) would escort the geophysical survey ship (*Geo Arctic*). As both ships must move continuously at near survey speed throughout this escort, it is essential that this work is carried out in ice conditions where the icebreaker is not obliged to undertake ramming operations.

ION used the Arctic Ice Regime Shipping System (AIRSS) to aid in their determination concerning suitable conditions for the survey. This system allows the Arctic Mariner/Ice Master to calculate the ''toughness'' of a particular ice regime. As a ''rule of thumb,'' seismic is normally considered achievable in ice where the calculation indicates navigation can safely be undertaken by the ice strengthened (Ice Class A1A, type A) geophysical ship, operating independently. ION states that it will take a conservative approach by using a heavy escort icebreaker. This means the icebreaker is normally working well below maximum power but does have a huge propulsive power capacity held in reserve in case ridges or other such ice features are encountered. Thus the icebreaker is breaking ice at a fraction of its maximum or rated capacity.

Compared to the aggressive icebreaking involved in the examples above, the icebreaking for in-ice seismic surveys is of a much different and considerably lower order. In most ice regimes expected to be encountered during ION's proposed survey, the *Polar Prince* will have about 5,123 HP available for propulsion, which is far less than the power of the heavy icebreaker *Healy* reported in Roth and Schmidt (2010). There would still be a direct correlation between icebreaking effort and icebreaking noise, although there are likely also many other variables such as thermal gradient, stage of ice development, speed of impact, propulsion system characteristics, hull and bow form, etc., that may differentiate the sounds produced during the proposed survey. In the examples provided in Roth and Schmidt (2010), the *Healy* appears to be backing and ramming in heavy multiyear ice (based on our interpretation of the pictures). Such conditions are beyond the allowable operational conditions of this project, and, if such conditions were encountered, the Type A geophysical ship could not follow such an ice-encumbered track of multiyear ice.

It should also be noted that the *Healy* was operating at maximum capacity during the measurements reported in Roth and Schmidt (2010), while during ice-seismic the escorting icebreaker rarely operates in excess of 50% capacity. Thus, accounting for the disparity in the horsepower ratings of the *Polar Prince* vs. the *Healy,* the *Polar Prince* is rendering an output, in terms of horsepower expended, of <25% each of that of the *Healy* during the reported measurements.

Based on available information regarding sounds produced by icebreaking in various ice regimes and the expected ice conditions during the proposed survey, NMFS determined that vessel sounds generated during ice breaking are likely to have source levels between 175 and 185 dB re 1 µPa-m.

(2) Impacts of Icebreaking Noise on Marine Mammals

Limited information is available about the effects of icebreaking ships on most species of marine mammals. Concerns have arisen in the past due to proposals (which were never realized) to conduct shipping of oil and gas in the Arctic via large icebreakers (Peterson, 1981). In the past, smaller icebreaking ships were used by the oil and gas industry in the Beaufort and Chukchi Seas to extend the offshore drilling period in support of offshore drilling, and several icebreakers or strengthened cargo ships have been used in the Russian northern sea route, as well as elsewhere in the Arctic and Antarctic (Armstrong, 1984; Barr and Wilson, 1985; Brigham, 1985).

The primary concern regarding icebreaking activities involves the production of intense underwater sound (Richardson *et al.,* 1995). Estimated source levels of the ice-breaking cargo vessel *MV Arctic* may be detectable by seals under fast ice at distances up to 20–35 km (12.4–21.8 mi) (Davis and Malme, 1997). However, icebreaking activities may also have non-acoustic effects, such as the potential for causing injury, ice entrapment of animals that follow the ship, and disruption of ice habitat (reviewed in Richardson *et al.,* 1989), though, as described below, these impacts are not anticipated during this action. The species of marine mammals that may be present and the nature of icebreaker activities are strongly influenced by ice type. Some species are more common in loose ice near the margins of heavy pack ice while others appear to prefer heavy pack ice. Propeller cavitation noise of icebreaking ships in loose ice is expected to be much lower than in areas of heavier pack ice or thick landfast ice where ship speed will be reduced, power levels will be higher, and there will be greater propeller cavitation and back-ramming (Richardson *et al.,* 1995).

Beluga Whales—Erbe and Farmer (1998) measured masked hearing thresholds of a captive beluga whale. They reported that the recording of a Canadian Coast Guard ship, *Henry Larsen,* ramming ice in the Beaufort Sea, masked recordings of beluga vocalizations at a noise-to-signal pressure ratio of 18 dB. That occurred when the noise pressure level was eight times as high as the call. In linear units, the ramming noise was 8 times as strong as the call (Erbe and Farmer, 1998). A similar study using a software model to estimate the zones of impact around icebreakers affecting beluga whales in the Beaufort Sea predicted that masking of beluga communication signals by ramming noise from an icebreaker could occur within 40–71 km (25–44 mi), depending on the location. However, Arctic beluga whales have shown avoidance of icebreakers when first detected (Erbe and Farmer, 2000), so individuals are unlikely to get close enough for effects such as masking to occur. In addition, vocal behavior of beluga whales in the St. Lawrence River in the presence of a ferry and a small motorboat have shown that belugas can change the types of calls they use, as well as shift the mean call frequency up during noise exposure (Lesage *et al.,* 1999). Therefore, it is possible that beluga whales in the Beaufort and Chukchi Seas may also have some mechanism that would allow them to adapt to ambient noise due to icebreaking activities.

In 1991 and 1994 in the Alaskan Beaufort Sea, Richardson *et al.* (1995b) recorded reactions of beluga and bowhead whales to playbacks of underwater propeller cavitation noise from the icebreaker *Robert Lemeur* operating in heavy ice. Migrating belugas were observed close to the playback projectors on three dates, but interpretable data were only collected on 17 groups for two of these occasions. A minimum of six groups apparently altered their path in response to the playback, but whales approached within a few hundred (and occasionally tens of) meters before exhibiting a response. Icebreaker sounds were estimated at 78–84 dB re 1µPa in the 1/3-octave band centered at 5,000 Hz, or 8–14 dB above ambient sound levels in that band, for the six groups that reacted. The authors estimated that reactions at this level would be estimated to occur at distances of approximately 10 km (6.2 mi) from an operating icebreaker.

Beluga whales are expected to avoid icebreaking vessels at distances of approximately 10 km (6.2 mi). The impacts of icebreaking associated with the seismic program on the behavior of belugas are expected to be temporary, lasting only as long as the activity is on-going, and would have a negligible impact on the species or stock.

Bowhead Whales—In 1991 and 1994 in the Alaskan Beaufort Sea, Richardson *et al.* (1995b) recorded reactions of beluga and bowhead whales to playbacks of underwater propeller cavitation noise from the icebreaker *Robert Lemeur* operating in heavy ice. Bowhead whales migrating in the nearshore appeared to tolerate exposure to projected icebreaker sounds at received levels up to 20 dB or more above ambient noise levels. However, some bowheads appeared to divert their paths to remain further away from the projected sounds, particularly when exposed to levels >20 dB above ambient. Turning frequency, surface duration, number of blows per surfacing, and two multivariate indices of behavior were significantly correlated with the signal-to-noise ratio >20 dB (and as low as 10 dB for turning frequency). The authors suggested that bowheads may commonly react to icebreakers at distances up to 10–50 km (6.2–31 mi), but note that reactions were highly dependent on several variables not controlled in the study.

There are few other studies on the reactions of baleen whales to icebreaking activities. During fall 1992, migrating bowhead whales apparently avoided (by at least 25 km [15.5 mi]) a drill site that was supported almost daily by intensive icebreaking activity in the Alaskan Beaufort Sea (Brewer *et al.,* 1993). However, bowheads also avoided a nearby drill site in the fall of another year that had little icebreaking support (LGL and Greenridge, 1987). Thus, level of contribution from icebreaking, ice concentration, and drilling noise resulting in bowhead responses is unknown.

Bowhead whales are expected to avoid vessels that are underway, including icebreakers. The impacts of icebreaking on the behavior of bowheads are likely to occur only if bowheads are still in the western portion of the proposed study area, although most bowheads will likely have passed through the survey area prior to the start of survey activities. The effects of icebreaking activities on bowhead whales are expected to be minor and short-term.

Pinnipeds— Reactions of walruses to icebreakers are described more thoroughly in the available literature than are reactions by other pinnipeds. When comparing the reaction distances of walrus to icebreaking ships vs. other ships traveling in open water, Fay *et al.* (1984) found that walrus reacted at longer distances to icebreakers. They were aware of the icebreaker when it was >2 km (1.2 mi) away, and females with pups entered the water and swam away when the ship was ~1 km (0.62 mi) away while adult males did so at distances of 0.1 to 0.3 km (0.1 to 0.2 mi). However, it was also noted that some walruses, ringed seals, and bearded seals also scrambled onto ice when an icebreaker was oriented toward them.

In another study of 202 walrus groups observed on ice floes during icebreaking activities, 32% dove into the water, and 6% became alert while on the ice (Brueggeman *et al.,* 1990, 1991, 1992). Concurrent aerial surveys indicated that walruses hauling out on ice floes may have avoided icebreaking activities within 10—15 km (6.2—9.3 mi) (Brueggeman *et al.,* 1990).

Ringed and bearded seals on pack ice approached by an icebreaker typically dove into the water within 0.93 km (0.58 mi) of the vessel but tended to be less responsive when the same ship was underway in open water (Brueggeman *et al.,* 1992). In another study, ringed and harp seals remained on the ice when an icebreaker was 1–2 km (0.62—1.2 mi) away, but seals often dove into the water when closer to the icebreaker (Kanik *et al.,* 1980 in Richardson *et al.,* 1995a). Ringed seals have also been seen feeding among overturned ice floes in the wake of icebreakers (Brewer *et al.,* 1993).

Seals swimming are likely to avoid approaching vessels by a few meters to a few tens of meters, while some ''curious'' seals are likely to swim toward vessels. Seals hauled out on ice also show mixed reaction to approaching vessels/icebreakers. Seals are likely to dive into the water if the icebreaker comes within 1 km (0.62 mi). The impact of vessel traffic on seals is expected to be negligible.

One potential impact from icebreaking activities is ice entrapment of pinnipeds that are following the vessels. However, NMFS does not consider this likely because ice formation at the time of the proposed survey consists mostly of loose annual ice floes that will not freeze into extensive pack ice. In addition, the time chosen for the icebreaking seismic survey would occur before ringed seals start constructing lairs in ice around early March.

Finally, the breaking of heavy pack ice or thick landfast ice could also indirectly increase the level of ambient noise due to broken ice floes cracking against each other, and effectively change the area's soundscape.

Vessel Sounds

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

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

For this project, the majority of any vessel noise would occur concurrently with sounds generated by seismic airguns or icebreaking and any potential impacts would be expected to be subsumed by the impacts of those louder sources.

Anticipated Effects on Habitat

The primary potential impacts to marine mammals and other marine species are associated with elevated sound levels produced by airguns and other active acoustic sources, noise generated from icebreaking, and breaking of ice during the seismic survey. However, other potential impacts to the surrounding habitat from physical disturbance are also possible.

Potential Impacts on Prey Species

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

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona, 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas *et al.,* 1993). In general, fish react more strongly to pulses of sound rather than a continuous signal (such as noise from a vessel or icebreaking) (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 proposed in-ice 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). However, by the time most bowhead whales reach the Chukchi Sea (October), they will likely no longer be feeding, or if feeding occurs it will be very limited. 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 inconsequential, and that would translate into negligible impacts on feeding mysticetes. Because ION will not start operations until early October, a substantial portion of the bowhead population that feeds in the Beaufort Sea during the fall westward migration will have already completed feeding and migrated out of the area before the proposed survey begins. Thus, the proposed activity is not expected to have any habitat-related effects on prey species or feeding marine mammals that could cause significant or long-term consequences for individual marine mammals or their populations.

Potential Impacts on Physical Environment

The proposed airgun operations will not result in any permanent impact on habitats used by marine mammals or to their food sources. The main impact issue associated with the proposed activities would be temporarily elevated noise levels and their associated direct effects on marine mammals, as discussed above, as well as the potential effects of icebreaking. The potential effects of icebreaking include locally altered ice conditions and the potential for the destruction of ringed seal lairs. However, ringed seals are not expected to enter these structures until later in the season, after the completion of ION's activities. Ice conditions at this time of year are typically quite variable with new leads opening and pressure ridges forming as wind and waves move the newly forming ice. This dynamic environment may be responsible for the mean date of permanent den entry on sea ice in the Beaufort Sea being later than on land (Amstrup and Gardner, 1994). The icebreaker and seismic vessel transit is not expected to significantly alter the formation of sea ice during this period.

Icebreaking would open leads in the sea ice along the vessel tracklines and could potentially destroy ringed seal lairs. However, ringed seals will not need lairs for pupping until the late winter or spring (after ION completes operations), so the impacts are not expected to impact pup survival. Ringed seals excavate lairs in snow that accumulates on sea ice near their breathing holes, and an individual seal maintains several breathing holes (Smith and Stirling, 1975). Ringed seal lairs are found in snow depths of 20–150 cm (8–59 in) (Smith and Stirling, 1975), and seals are not expected to enter lairs before the proposed seismic survey takes place. Damage to lairs caused by survey activities is not expected to exceed that which occurs naturally, and lair destruction in the early winter would likely not impact ringed seal survival. Lanugal pups born in the spring can become hypothermic if wetted, but by early winter they are robust to submersion having spent the entire summer at sea (Smith *et al.,* 1991). The highest density of ringed seals reported from aerial surveys conducted during spring when seals were emerging from lairs was in areas with water depth ranging from 5–35 m (16.4–115 ft) (Frost *et al.,* 2004). A relatively small proportion (5%; 364 km [226 mi]) of the proposed survey trackline is planned in that area.

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 are expected to return to their pre-disturbance behavior once the seismic activity ceases (McCauley *et al.,* 2000a, b; 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.

Refueling at sea has the potential to impact the marine environment if a spill were to occur. However, there are multiple procedures and safeguards in place to avoid such an accident. Prior to conducting a fuel transfer, the area around the vessels would be checked for the presence of marine mammals and operations delayed until the area is clear. A leak during refueling would be detected and the system shut down within a maximum of 30 seconds. The diesel oil transfer pump is rated at 50 IGPM @ 60 ft pressure head. Therefore, the maximum amount of oil that could be spilled during a transfer is 25 imperial gallons. This risk is reduced further with the standard use of 'dry-break' fittings for fuel transfers.

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

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

Relevant Subsistence Uses

Subsistence hunting and fishing continue to be prominent in the household economies and social welfare of some Alaskan residents, particularly among those living in small, rural villages (Wolfe and Walker, 1987). The disturbance and potential displacement of marine mammals by sounds from the proposed marine surveys are the principal concerns related to subsistence use of the area. Subsistence remains the basis for Alaska Native culture and community. Marine mammals are legally hunted in Alaskan waters by coastal Alaska Natives. In rural Alaska, subsistence activities are often central to many aspects of human existence, including patterns of family life, artistic expression, and community religious and celebratory activities. Additionally, the animals taken for subsistence provide a significant portion of the food that will last the community throughout the year. The main species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses, and polar bears. (Both the walrus and the polar bear are under the USFWS' jurisdiction.) The importance of each of these species varies among the communities and is largely based on availability.

(1) Bowhead Whales

Bowhead whale hunting is a key activity in the subsistence economies of Barrow and other Native communities along the Beaufort Sea and Chukchi Sea coast. The whale harvests have a great influence on social relations by strengthening the sense of Inupiat culture and heritage in addition to reinforcing family and community ties.

An overall quota system for the hunting of bowhead whales was established by the International Whaling Commission in 1977. The quota is now regulated through an agreement between NMFS and the Alaska Eskimo Whaling Commission (AEWC). The AEWC allots the number of bowhead whales that each whaling community may harvest annually during five-year periods (USDI/BLM, 2005). NMFS proposed continuation of the bowhead hunt for the five-year period 2008–2012 (NMFS, 2008b), and in June 2012, NMFS released a Draft Environmental Impact Statement proposing to continue the bowhead hunt for the period 2013–2017/2018 (NMFS, 2012).

The community of Barrow hunts bowhead whales in both the spring and fall during the whales' seasonal migrations along the coast. Often the bulk of the Barrow bowhead harvest is taken during the spring hunt. However, with larger quotas in recent years, it is common for a substantial fraction of the annual Barrow quota to remain available for the fall hunt. The communities of Nuiqsut and Kaktovik participate only in the fall bowhead harvest. The fall migration of bowhead whales that summer in the eastern Beaufort Sea typically begins in late August or September. Fall migration into Alaskan waters is primarily during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy, 1993; LGL and Greeneridge, 1996; Greene, 1997; Greene *et al.,* 1999; Blackwell *et al.,* 2004).

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

The spring hunts at Wainwright and Barrow occur after leads open due to the deterioration of pack ice; the spring hunt typically occurs from early April until the first week of June. The location of the fall subsistence hunt depends on ice conditions and (in some years) industrial activities that influence the bowheads as they move west (Brower, 1996). In the fall, subsistence hunters use aluminum or fiberglass boats with outboards. At Barrow the fall hunt usually begins in mid-September, and mainly occurs in the waters east and northeast of Point Barrow. In 2007 however, all bowheads taken in fall at Barrow were harvested west of Pt. Barrow in the Chukchi Sea (Suydam *et al.,* 2008). The whales have usually left the Beaufort Sea by late October (Treacy, 2002a; 2002b).

The scheduling of this seismic survey was introduced to representatives of those concerned with the subsistence bowhead hunt including the AEWC and the North Slope Borough (NSB) Department of Wildlife Management during a meeting in Barrow on December 15, 2009. Additional meetings occurred in 2010, 2011, and 2012 with more planned later in 2012 to share information regarding the survey with other members of the subsistence hunting community. The timing of the proposed geophysical survey in October–December will not affect the spring bowhead hunt. The fall bowhead hunt may be occurring near Barrow during October, and operations will be coordinated with the AEWC. ION will operate at the eastern end of the survey area until fall whaling in the Beaufort Sea near Barrow is finished. Fall bowhead whale hunts by members of the communities of Kaktovik and Nuiqsut will likely be completed prior to October.

Whaling communities of the Bering Strait area, such as Gambell and Savoonga on St. Lawrence Island, hunt bowheads in the late fall (typically around Thanksgiving). Because ION intends to conduct operations in the Beaufort and Chukchi Seas until early to mid-December, ION's vessel transits through the Bering Strait should not interfere with these late fall hunts.

(2) Beluga Whales

Beluga whales are available to subsistence hunters at Barrow in the spring when pack-ice conditions deteriorate and leads open up. Belugas may remain in the area through June and some-times into July and August in ice-free waters. Hunters usually wait until after the spring bowhead whale hunt is finished before turning their attention to hunting belugas. The average annual harvest of beluga whales taken by Barrow for 1962–1982 was five (MMS, 1996). The Alaska Beluga Whale Committee recorded that 23 beluga whales had been harvested by Barrow hunters from 1987 to 2002, ranging from 0 in 1987, 1988 and 1995 to the high of 8 in 1997 (Fuller and George, 1999; Alaska Beluga Whale Committee, 2002 in USDI/BLM, 2005). The timing of the proposed survey will not overlap with the beluga harvest.

(3) Ice Seals

Ringed seals are hunted mainly from October through June. Hunting for these smaller mammals is concentrated during winter because bowhead whales, bearded seals and caribou are available through other seasons. In winter, leads and cracks in the ice off points of land and along the barrier islands are used for hunting ringed seals. The seismic survey would be largely in offshore waters where the activities would not influence ringed seals in the nearshore areas where they are hunted.

The spotted seal subsistence hunt peaks in July and August, at least in 1987 to 1990, but involves few animals. Spotted seals typically migrate south by October to overwinter in the Bering Sea, and therefore the proposed October–December survey will not affect hunting of this species. Admiralty Bay, less than 60 km (37 mi) to the east of Barrow, is a location where spotted seals are harvested. Spotted seals are also occasionally hunted in the area off Point Barrow and along the barrier islands of Elson Lagoon to the east (USDI/BLM, 2005). The average annual spotted seal harvest by the community of Barrow from 1987–1990 was one (Braund *et al.,* 1993)

Bearded seals, although not favored for their meat, are important to subsistence activities in Barrow because of their skins. Six to nine bearded seal hides are used by whalers to cover each of the skin-covered boats traditionally used for spring whaling. Because of their valuable hides and large size, bearded seals are specifically sought. Bearded seals are harvested during the summer months in the Beaufort Sea (USDI/BLM, 2005). The animals inhabit the environment around the ice floes in the drifting ice pack, so hunting usually occurs from boats in the drift ice. Braund *et al.* (1993) mapped the majority of bearded seal harvest sites from 1987 to 1990 as being within ~24 km (~15 mi) of Point Barrow. The average annual take of bearded seals by the Barrow community from 1987 to 1990 was 174. Because bearded seal hunting typically occurs during the summer months, the proposed October–December survey is not expected to affect bearded seal harvests.

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.''

Seismic surveys and associated icebreaking operations have the potential to impact marine mammals hunted by Native Alaskans. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously in this document) is avoidance of the ensonified area. In the case of bowhead whales, this often means that the animals could divert from their normal migratory path by up to several kilometers. Additionally, general vessel presence in the vicinity of traditional hunting areas could negatively impact a hunt.

In the case of subsistence hunts for bowhead whales in the Beaufort and Chukchi Seas, there could be an adverse impact on the hunt if the whales were deflected seaward (further from shore) in traditional hunting areas. The impact would be that whaling crews would have to travel greater distances to intercept westward migrating whales, thereby creating a safety hazard for whaling crews and/or limiting chances of successfully striking and landing bowheads. Native knowledge indicates that bowhead whales become increasingly ''skittish'' in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing (which makes harvesting more difficult). Additionally, natives report that bowheads exhibit angry behaviors in the presence of seismic, such as tail-slapping, which translate to danger for nearby subsistence harvesters.

However, due to its proposed time and location, ION's proposed in-ice seismic survey in the Beaufort and Chukchi Seas would be unlikely to result in the aforementioned impacts. As discussed earlier in detail, the only potential impacts on subsistence use of marine mammals from ION's proposed icebreaking seismic survey during October–December period are the fall bowhead hunt and ringed seal harvest. Nevertheless, the proposed seismic survey is expected to occur in waters far offshore from the regular seal hunting areas, and ION indicates it would elect to operate at the eastern end of the survey area until fall whaling in the Beaufort Sea near Barrow is finished, thus reducing the likelihood of interfering with subsistence use of marine mammals in the vicinity of the project area.

Proposed Mitigation

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

For the proposed ION in-ice seismic survey in the Beaufort and Chukchi Seas, ION worked with NMFS and proposed the following mitigation measures to minimize the potential impacts to marine mammals in the project vicinity as a result of the marine seismic survey activities.

As part of the application, ION submitted to NMFS a Marine Mammal Monitoring and Mitigation Program (4MP) for its in-ice seismic survey in the Beaufort and Chukchi Seas during the 2012 fall season. The objectives of the 4MP are:

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

The 4MP may be modified or supplemented based on comments or new information received from the public during the public comment period or from the peer review panel (see the ''Monitoring Plan Peer Review'' section later in this document).

Mitigation Measures Proposed in ION's IHA Application

ION listed the following protocols to be implemented during its marine seismic survey in the Beaufort and Chukchi Seas.

(1) Exclusion Zones

Under current NMFS guidelines, ''exclusion zones'' for marine mammals around industrial sound sources are customarily defined as the distances within which received sound levels are ≥180 dB re 1 μPa (rms) for cetaceans and ≥190 dB re 1 μPa (rms) for pinnipeds. These criteria are based on an assumption that sound energy at lower received levels will not injure these animals or impair their hearing abilities but that higher received 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 zone (Richardson *et al.,* 1995; see above).

Received sound levels were modeled for the full 26 airgun, 4,450 in^3 array in relation to distance and direction from the source (Zykov *et al.,* 2010). Based on the model results, Table 1 in this document shows the distances from the airguns where ION predicts that received sound levels will drop below 190, 180, and 160 dB re 1 μPa (rms). A single 70-in^3 airgun would be used during turns or if a power down of the full array (see below) is necessary due to the presence of a marine mammal within or about to enter the applicable exclusion zone of the full airgun array. To model the source level of the 70-in^3 airgun, ION used the measurements of a 30-in^3 airgun. Underwater sound propagation of a 30-in^3 airgun was measured in <100 m (328 ft) of water near Harrison Bay in 2007, and results were reported in Funk *et al.* (2008). The constant term of the resulting equation was increased by 2.45 dB based on the difference between the volume of the two airguns [2.45 = 20Log(70/30)∧(⅓)]. The 190 and 180 dB (rms) distances for the 70-in^3 airgun from the adjusted equation, 19 m (62 ft) and 86 m (282 ft) respectively, would be used as the exclusion zones around the single 70 in^3 airgun in all water depths until results from field measurements are available.

An acoustics contractor would perform the direct measurements of the received levels of underwater sound versus distance and direction from the energy source arrays using calibrated hydrophones (see below ''Sound Source Verification'' in the ''Proposed Monitoring'' section). The acoustic data would be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the size of the exclusion zones. The field report will be made available to NMFS and the Protected Species Observers (PSOs) within 120 hrs of completing the measurements. The mitigation measures to be implemented at the 190 and 180 dB (rms) sound levels would include power downs and shut downs as described below.

TABLE 1—MARINE MAMMAL EXCLUSION ZONES FROM THE 26 AIRGUN, 4,450-IN^3 ARRAY, FOR SPECIFIC CATEGORIES BASED ON THE WATER DEPTH

rms (dB re. 1 μPa)	Exclusion and disturbance zones (meters)		
	less than 100 m	100 m–1,000 m	more than 1,000 m
190	600	180	180
180	2,850	660	580
160	27,800	42,200	31,600

(2) Speed or Course Alteration

If a marine mammal (in water) is detected outside the exclusion zone and, based on its position and the relative motion, is likely to enter the exclusion zone, the vessel's speed and/or direct course shall be changed in a manner that also minimizes the effect on the planned objectives when such a maneuver is safe.

Another measure proposes to avoid concentrations or groups of whales by all vessels in transit under the direction of ION. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

All vessels during transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any barge or transit vessel approaches within 1.6 km (1 mi) of observed bowhead whales, the vessel operator shall take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

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

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

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

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

(E) 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 proposed mitigation measures below would apply:

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

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

(3) Ramp Ups

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 is to ''warn'' marine mammals in the vicinity of the airguns and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed seismic 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 or when no airguns have been firing) will begin by firing a single airgun in the array. A full ramp up, following a cold start, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin.

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

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

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

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

During turns and transit between seismic transects, the 70 in^3 mitigation gun will remain operational. The ramp up procedure will still be followed when increasing the source levels from one airgun to the full array. PSOs will be on duty whenever the airguns are firing during daylight and during the 30 minute periods prior to full ramp ups. Daylight will occur for ~11 hours/day at the start of the survey in early October diminishing to ~3 hours/day in mid-November.

(4) Power Down Procedures

A power down involves decreasing the number of airguns in use such that the radii of the 190 and 180 dB re 1 μPa (rms) zones are decreased to the extent that observed marine mammals are not in the applicable exclusion zone. A power down may also occur when the vessel is moving from one seismic line to another. During a power down, only one airgun is operated. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of the seismic vessel in the area, and (b) retain the option of initiating a ramp up to full array under poor visibility conditions. In contrast, a shutdown is when all airgun activity is suspended (see next section).

If a marine mammal is detected outside the exclusion zone but is likely to enter the exclusion zone, and if the vessel's speed and/or course cannot be changed to avoid having the mammal enter the exclusion zone, the airguns may (as an alternative to a complete shutdown) be powered down before the mammal is within the exclusion zone. Likewise, if a mammal is already within the exclusion zone when first detected, the airguns will be powered down immediately if this is a reasonable alternative to a complete shutdown. During a power down of the array, the number of guns operating will be reduced to a single 70 in^3 airgun. The pre-season estimates of the 190 dB re 1 μPa (rms) and 180 dB re 1 μPa (rms) exclusion zones around the power down source are 19 m (62 ft) and 86 m (282 ft), respectively. The 70 in^3 airgun power down source will be measured during acoustic sound source measurements conducted at the start of seismic operations. If a marine mammal is detected within or near the applicable exclusion zone around the single 70 in^3 airgun, it too will be deactivated, resulting in a complete shutdown (see next subsection).

Marine mammals hauled out on ice may enter the water when approached closely by a vessel. If a marine mammal on ice is detected by PSOs within the exclusion zones, it will be watched carefully in case it enters the water. In the event the animal does enter the water and is within an applicable exclusion zone of the airguns during seismic operations, a power down or other necessary mitigation measures will immediately be implemented. If the animal does not enter the water, it will not be exposed to sounds at received levels for which mitigation is required; therefore, no mitigation measures will be taken.

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

- Is visually observed to have left the exclusion zone, or
- Has not been seen within the zone for 15 min in the case of pinnipeds (excluding walruses) or small odontocetes, or
- Has not been seen within the zone for 30 min in the case of mysticetes or large odontocetes.

(5) Shutdown Procedures

The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the then-applicable exclusion zone and a power down is not practical or adequate to reduce exposure to less than 190 or 180 dB re 1 μPa (rms). The operating airgun(s) will also be shut down completely if a marine mammal approaches or enters the estimated exclusion zone around the reduced source (one 70 in^3 airgun) that will be used during a power down.

Airgun activity will not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone, or if it has not been seen within the zone for 15 min (pinnipeds and small odontocetes) or 30 min (mysticetes and large odontocetes). Ramp up procedures will be followed during resumption of full seismic operations after a shutdown of the airgun array.

Additional Mitigation Measures Proposed by NMFS

In addition to ION's proposed mitigation measures discussed above, NMFS proposes the following additional measures during the long periods of darkness when the seismic survey is proposed. Specifically in this case, With the exception of turns when starting a new trackline, or short transits or maintenance with a duration of less than one hour, NMFS does not recommend keeping one airgun (also referred to as the ''mitigation gun'' in past IHAs) firing for long periods of time during darkness or other periods of poor visibility, as it would only introduce more noise into the water with no potential near-term avoidance benefits for marine mammals.

Furthermore, NMFS proposes that the airgun array be shut down if a pinniped is sighted hauled out on ice within the underwater exclusion zone (received level 190 dB re 1 μPa (rms)). Even though the pinniped may not be exposed to in-air noise levels that could be considered a take, the presence of the seismic vessel could prompt the animal to slip into the water, and thus be exposed to a high intensity sound field as a result.

Mitigation Measures for Subsistence Activities

(1) Subsistence Mitigation Measures

Since ION's proposed October–December in-ice seismic survey in the Beaufort and Chukchi Seas is not expected to affect subsistence use of marine mammals by Alaskan Natives due to its proposed time and location, no specific mitigation measures are proposed other than those general mitigation measures discussed above.

(2) Plan of Cooperation (POC)

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

ION has developed a ''Plan of Cooperation'' (POC) for the proposed 2012 seismic survey in the Beaufort and Chukchi Seas in consultation with representatives of Barrow, Nuiqsut, Kaktovik, and Wainwright and subsistence users within these communities. NMFS received a final draft of the POC on May 22, 2012. The final draft POC is posted on NMFS Web site at *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.*

ION will continue to engage with the communities of Barrow, Nuiqsut, Kaktovik, and Wainwright to identify and avoid areas of potential conflict. The meetings with stakeholders that took place in 2010 and 2011 are listed in Table 16 and Table 17, respectively, of ION's IHA application. The meetings that have taken place in 2012, as well as additional proposed meetings, are listed in Table 18 of ION's IHA application. Members of marine mammal co-management groups and groups that address subsistence activities were specifically notified of the public meetings so that they could provide input. A record of all consultation with subsistence users will be included in the 2012 Final POC document.

Mitigation Conclusions

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

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

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

Proposed Monitoring and Reporting

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

Proposed Monitoring Measures

The monitoring plan proposed by ION can be found in the 4MP. The plan may be modified or supplemented based on comments or new information received from the public during the public comment period. A summary of the primary components of the plan follows.

(1) Protected Species Observers

Vessel-based monitoring for marine mammals will be performed by trained PSOs throughout the period of survey activities, supplemented by the officers on duty, to comply with expected provisions in the IHA (if issued). The observers will monitor the occurrence and behavior of marine mammals near the survey vessels during all daylight periods. 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'' as defined by NMFS.

A. Number of Observers

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.

An experienced field crew leader will supervise the PSO team onboard the survey vessels. ION's proposed survey will occur in October–December when the number of hours of daylight is significantly reduced, and thus will require fewer PSOs to be aboard the survey vessel than required for surveys conducted during the open water season with nearly 24 hrs of daylight. PSOs aboard the icebreaker operating 0.5–1 km (0.31–0.62 mi) ahead of the survey vessel will provide early detection of marine mammals along the survey track. Three PSOs will be stationed aboard the icebreaker *Polar Prince* to take advantage of this forward operating platform and provide advance notice of marine mammals to the PSO on the survey vessel. Three PSOs will be stationed aboard the survey vessel *Geo Arctic* to monitor the exclusion zones centered on the airguns and to request mitigation actions when necessary.

B. Observer Qualifications and Training

Crew leaders and most other biologists serving as observers will be individuals with recent experience as observers during one or more seismic monitoring projects in Alaska, the Canadian Beaufort Sea, or other offshore areas.

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. Résumés for all individuals will be provided to NMFS for review and acceptance of their qualifications. Inupiat observers will be experienced in the region, familiar with the marine mammals of the area, and complete an approved observer training course designed to familiarize individuals with monitoring and data collection procedures. A PSO handbook, adapted for the specifics of the planned survey program, will be prepared and distributed beforehand to all PSOs (see summary below).

Biologist-observers and Inupiat observers will also complete a two or three-day training and refresher session together on marine mammal monitoring, to be conducted shortly before the anticipated start of the seismic survey. When possible, experienced observers will be paired with inexperienced observers. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- Review of the marine mammal monitoring plan for this project, including any amendments specified by NMFS in the IHA (if issued);
- Review of marine mammal sighting, identification, and distance estimation methods using visual aids;
- Review of operation of specialized equipment (reticle binoculars, night vision devices (NVDs), and GPS system);
- Review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on marine mammal sightings, monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers;
- Review of the specific tasks of the Inupiat Communicator; and
- Exam to ensure all observers can correctly identify marine mammals and record sightings.

C. PSO Handbook

A PSOs' Handbook will be prepared for ION's 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 ION project:

- Summary overview descriptions of the project, marine mammals and underwater noise, the marine mammal monitoring program (vessel-based, aerial, acoustic measurements), the NMFS' IHA (if issued) and other regulations/permits/agencies, the Marine Mammal Protection Act;
- Monitoring and mitigation objectives and procedures, initial 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, common coding mistakes, electronic database; navigational, marine physical, field data sheet;
- List of species that might be encountered: identification cues, natural history information;
- Use of specialized field equipment (reticle binoculars, NVDs, forward-looking infrared (FLIR) system);
- Reticle binocular distance scale;
- Table of wind speed, Beaufort wind force, and sea state codes;
- Data storage and backup procedures;
- Safety precautions while onboard;
- Crew and/or personnel discord; conflict resolution among PSOs and crew;
- Drug and alcohol policy and testing;
- Scheduling of cruises and watches;
- Communication availability and procedures;
- List of field gear that will be provided;
- Suggested list of personal items to pack;
- Suggested literature, or literature cited; and
- Copies of the NMFS IHA and USFWS LOA when available.

(2) Monitoring Methodology

A. General Monitoring Methodology

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

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

- Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if determinable), bearing and distance from observer, apparent reaction to activities (*e.g.,* none, avoidance, approach, etc.), closest point of approach, and pace;
- Additional details for any unidentified marine mammal or unknown observed;
- Time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare; and
- The positions of other vessel(s) in the vicinity of the observer location.

The ship's position, speed of the vessel, water depth, sea state, ice cover, visibility, airgun status (ramp up, mitigation gun, or full array), and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars 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. However, previous experience has shown that a Class 1 eye-safe device was not able to measure distances to seals more than about 70 m (230 ft) away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 600 m (1,968 ft), the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20% when given immediate feedback about actual distances during training.

When a marine mammal is seen within the exclusion zone applicable to that species, the geophysical crew will be notified immediately so that mitigation measures required by the IHA (if issued) can be implemented. It is expected that the airgun array will be shut down within several seconds, often before the next shot would be fired, and almost always before more than one additional shot is fired. The protected species observer will then maintain a watch to determine when the mammal(s) appear to be outside the exclusion zone such that airgun operations can resume.

ION will provide or arrange for the following specialized field equipment for use by the onboard PSOs: 7 × 50 reticle binoculars, Big-eye binoculars or high power image-stabilized binoculars, GPS unit, laptop computers, night vision binoculars, digital still and possibly digital video cameras in addition to the above mentioned FLIR camera system (see below).

B. Monitoring At Night and In Poor Visibility

Night-vision equipment (Generation 3 binocular image intensifiers, or equivalent units) will be available for use when/if needed. Past experience with NVDs in the Beaufort 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). A FLIR camera system mounted on a high point near the bow of the icebreaker will also be available to assist with detecting the presence of seals and polar bears on ice and, perhaps also in the water, ahead of the airgun array. The FLIR system detects thermal contrasts and its ability to sense these differences is not dependent on daylight.

Additional details regarding the monitoring protocol during NVD and FLIR system use has been developed in order to collect data in a standardized manner such that the effectiveness of the two devices can be analyzed and compared.

B. (1) FLIR and NVD Monitoring

The infrared system is able to detect differences in the surface temperature of objects making it potentially useful during both daylight and darkness periods. NVDs, or light intensifiers, amplify low levels of ambient light from moonlight or sky glow light in order to provide an image to the user. Both technologies have the potential to improve monitoring and mitigation efforts in darkness. However, they remain relatively unproven in regards to their effectiveness under the conditions and it the manner of use planned for this survey. The protocols for FLIR and NVD use and data collection described below are intended to collect the necessary data in order to evaluate the ability of these technologies to aid in the detection of marine mammals from a vessel.

- All PSOs will monitor for marine mammals according to the procedures outlined in the PSO handbook.
- One PSO will be responsible for monitoring the FLIR system (IR–PSO) during most darkness and twilight periods. The on-duty IR–PSO will monitor the IR display and alternate between the two search methods described below. If a second PSO is on watch, they will scan the same area as the FLIR using the NVDs for comparison. The two PSOs will coordinate what area is currently being scanned.
- The IR–PSO should rotate between the search methods (see below) every 30 minutes in the suggested routine (see below):
  - 00:00–00:30: Method I
  - 00:30–01:00: Method II, Port side
  - 01:00–01:30: Method I
  - 01:30–02:00: Method II, Starboard side

B. (2) FLIR Search Methods

The FLIR system consists of a camera that will be mounted on high point in front of the vessel. The camera is connected to a joystick control unit (JCU) and a display monitor that will be located on the bridge of the vessel. The IR–PSO will manually control the view that is displayed by adjusting the pan (360° continuous pan) and tilt (+/−90° tilt) settings using the JCU. The FLIR manufacturer has indicated that they have tested the FLIR unit (model M626L) to −25 °C (−13 °F), but expect that it will operate at colder temperatures. During the time of the proposed seismic survey, the average minimum temperatures at Prudhoe Bay in October and November are +10 °F and −10 °F, respectively. Colder temperatures are certainly likely at times, but overall the temperatures should generally be within the operational range of the equipment.

As noted above, two different search methods will be implemented for FLIR monitoring and results from the two will be compared. The first method involves a back-and-forth panning motion and the second utilizes the FLIR unit focused on a fixed swath ahead and to one side of the vessel track:

Method I: Set the horizontal tilt of the camera to an angle that provides an adequate view out in front of the vessel and also provides good resolution to potential targets (this will likely mean that the lower portion of the view displayed on the monitor is of an area relatively close to the vessel (<100 m [328 ft]) while the middle and upper portions of the view are at greater distances (500–2,000 m [1,640–6,562 ft]). Pan back and forth across the forward 180° of the vessels heading at a slow-scanning rate of approximately 1–2°/sec, as one would with binoculars. This method is intended to replicate the type of observations conducted using binoculars and cover a relatively wider swatch compared to Method II. It should produce sightings data that can be analyzed using line-transect methodologies to estimate marine mammal densities in the survey area.

Method II: Set the horizontal tilt of the camera to an angle that provides an adequate view out in front of the vessel (similar or identical to the above), and then set the camera at a fixed position that creates a swath of view off the bow and to one side of the vessel (see Figure 1 of ION's monitoring plan). This method essentially establishes a fixed-strip width that is intended to produce sightings data that can be analyzed using strip-transect methodologies to estimate marine mammal densities.

B. (3) NVD Methods

The NVDs are goggles worn by the observer and are to be used in a similar fashion as binoculars. When observing in conjunction with the FLIR system, the objective will be to replicate the monitoring methodology being employed by the FLIR system. Method I requires a full 180° scan (or as large of a range as possible from the observer's location) with the NVDs, and Method II requires a focused scan of the ~60° swath being monitored by the FLIR system.

C. Field Data-Recording, Verification, Handling, and Security

The observers will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. 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 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.

In addition to routine PSO duties, observers will use Traditional Knowledge and Natural History datasheets to record observations that are not captured by the sighting or effort data. Copies of these records will be available to observers for reference if they wish to prepare a statement about their observations. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

D. Effort and Sightings Data Collection Methods

Observation effort data will be designed to capture the amount of PSO effort itself, environmental conditions that impact an observer's ability to detect marine mammals, and the equipment and method of monitoring being employed. These data will be collected every 30 minutes or when an effort variable changes (*e.g.,* change in the equipment or method being used to monitor, on/off-signing PSO, etc.), and will be linked to sightings data. Effort and sightings data forms are the same forms used during other marine mammal monitoring in the open water season, but additional fields have been included to capture information specific to monitoring in darkness and to more accurately describe the observation conditions. The additional fields include the following.

- Observation Method: FLIR, NVD, spotlight, eye (naked eye or regular binoculars), or multiple methods. This data is collected every 30 minutes with the Observer Effort form and with every sighting.
- Cloud Cover: Percentage. This can impact lighting conditions and reflectivity.
- Precipitation Type: Fog, rain, snow, or none.
- Precipitation Reduced Visibility: Confirms whether or not visibility is reduced due to precipitation. This will be compared to the visibility distance (# km) to determine when visibility is reduced due to lighting conditions versus precipitation.
- Daylight Amount: Daylight, twilight, dark. The addition of the twilight field has been included to record observation periods where the sun has set and observation distances may be reduced due to lack of light.
- Light Intensity: Recorded in footcandles (fc) using an incident light meter. This procedure was added to quantify the available light during twilight and darkness periods and may allow for light-intensity bins to be used during analysis.

Analysis of the sightings data will include comparisons of nighttime (FLIR and NVD) sighting rates to daylight sighting rates. FLIR and NVD analysis will be independent of each other and according to method (I or II) used. Comparison of NVD and FLIR sighting rates will allow for a comparison of marine mammal detection ability of the two methods. However, results and analyses could be limited if relatively few sightings are recorded during the survey.

(3) Acoustic Monitoring Plan

A. Sound Source Measurements

As described above, received sound levels were modeled for the full 26 airgun, 4,450 in^3 array in relation to distance and direction from the source (Zykov *et al.,* 2010). These modeled distances will be used as temporary exclusion zones until measurements of the airgun sound source are conducted. The measurements will be made at the beginning of the field season, and the measured radii will be used for the remainder of the survey period. An acoustics contractor with experience in the Arctic conducting similar measurements in recent years will use their equipment to record and analyze the underwater sounds and write the summary reports as described below.

The objectives of the sound source measurements planned for 2012 in the Beaufort Sea will be (1) to measure the distances in potentially ice covered waters in the broadside and endfire directions at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 μPa (rms) for the energy source array combinations that may be used during the survey activities, and (2) measure the sounds produced by the icebreaker and seismic vessel as they travel through sea ice. Conducting the sound source and vessel measurements in ice-covered waters using bottom founded recorders creates a risk of not being able to retrieve the recorders and analyze the data until the following year. If the acoustic recorders are not deployed or are unable to be recovered because of too much sea ice, ION will use measurements of the same airgun source taken in the Canadian Beaufort Sea in 2010, along with sound velocity measurements taken in the Alaskan Beaufort Sea at the start of the 2012 survey to update the propagation model and estimate new exclusion zones. These modeled results will then be used for mitigation purposes during the remainder of the survey.

The airgun configurations measured will include at least the full 26 airgun array and the single 70 in^3 mitigation airgun that will be used during power downs. The measurements of airgun array sounds will be made by an acoustics contractor at the beginning of the survey and the distances to the various radii will be reported as soon as possible after recovery of the equipment. The primary area of concern will be the 190 and 180 dB re 1 μPa (rms) exclusion zones for pinnipeds and cetaceans, respectively, and the 160 dB re 1 μPa Level B harassment (for impulsive sources) radii. In addition to reporting the radii of specific regulatory concern, nominal distances to other sound isopleths down to 120 dB re 1 μPa (rms) will be reported in increments of 10 dB.

Data will be previewed in the field immediately after download from the hydrophone instruments. An initial sound source analysis will be supplied to NMFS and the airgun operators within 120 hours of completion of the measurements. 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 issued to NMFS as part of the 90-day report following completion of the acoustic program.

B. Seismic Hydrophone Streamer Recordings of Vessel Sounds

Although some measurements of icebreaking sounds have previously been reported, acoustic data on vessels traveling through relatively light ice conditions, as will be the case during the proposed survey, are not available. In order to gather additional information on the sounds produced by this type of icebreaking, ION proposes to use the hydrophones in the seismic streamer on a routine basis throughout the survey. Once every hour the airguns would not be fired at 2 consecutive intervals (one seismic pulse interval is typically ~18 seconds, so there will be ~54 seconds between seismic pulses at this time) and instead a period of background sounds would be recorded, including the sounds generated by the vessels. Over the course of the survey this should generate as many as 750 records of vessel sounds traveling through various ice conditions (from open water to 100% cover juvenile first year ice or lighter multi-year ice). The acoustic data during each sampling period from each hydrophone along the 9 km (5.6 mi) streamer would be analyzed and used to estimate the propagation loss of the vessel sounds. The acoustic data received from the hydrophone streamer would be recorded at an effective bandwidth of 0–400 Hz. In order to estimate sound energy over a larger range of frequencies (broadband), results from previous measurements of icebreakers could be generalized and added to the data collected during this project.

C. Over-winter Acoustic Recorders

In order to collect additional data on the propagation of sounds produced by icebreaking and seismic airguns in ice-covered waters, as well as on vocalizing marine mammals, ION intends to collaborate with other Industry operators to deploy acoustic recorders in the Alaskan Beaufort Sea in fall 2012, to be retrieved during the 2013 open-water season.

During winter 2011–2012, AURAL acoustic recorders were deployed at or near each of the 5 acoustic array sites established by Shell for monitoring the fall bowhead whale migration through the Beaufort Sea, as well as one site near the shelf break in the central Alaskan Beaufort Sea. These recorders will be retrieved in July 2012, when Shell deploys Directional Autonomous Seafloor Acoustic Recorders (DASARs) at 5 array locations. When the DASAR arrays are retrieved in early October, ION intends to coordinate with Shell to re-deploy the 6 AURAL recorders to the same locations used during the 2011–2012 winter. Redeploying the recorders in the same locations will provide comparable data from a year with little to no offshore industrial activity (2011) to a year with more offshore industrial activity (2012). Acoustic data from the over-winter recorders will be analyzed to address the following objectives:

- Characterize the sounds and propagation distances produced by ION's source vessel, icebreaker, and airguns on and to the edge of the U.S. Beaufort Sea shelf,
- Characterize ambient sounds and marine mammal calls during October and November to assess the relative effect of ION's seismic survey on the background conditions, and to characterize marine mammal calling behavior, and
- Characterize ambient sound and enumerate marine mammal calls through acoustic sampling of the environment form December 2012 through July 2013, when little or no anthropogenic sounds are expected.

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 independent peer review panels to review ION's mitigation and monitoring plan in its IHA applications submitted in 2010 and 2011 for taking marine mammals incidental to the proposed seismic survey in the Beaufort and Chukchi Seas, during 2010 and 2011. The panels met on March 25 and 26, 2010, and on March 9, 2011, and provided their final report to NMFS on April 22, 2010 and on April 27, 2011, respectively. The full panel reports can be viewed at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.*

ION's proposed 2012 action is essentially the same as described in its 2010 and 2011 IHA applications. NMFS worked with ION in 2010 and 2011 to address the peer review panels' recommendations on its 2010 and 2011 4MPs. Since ION's 2012 4MP addressed all issues raised during the 2010 and 2011 peer reviews and incorporated all of NMFS' requested changes, no peer-review of ION's 2012 4MP was conducted.

In 2010, NMFS provided the panel with ION's 4MP and asked the panel to address the following questions and issues for ION's plan:

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

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

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

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

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

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

In 2011, NMFS revised its guidance to the peer review panel and asked the panel to focus on more specific questions:

(1) Are the applicant's stated objectives the most useful for understanding impacts on marine mammals and otherwise accomplishing the goals stated in the paragraph above?

(2) Are the applicant's stated objectives able to be achieved based on the methods described in the plan?

(3) Are there techniques not proposed by the applicant, or modifications to the techniques proposed by the applicant, that should be considered for inclusion in the applicant's monitoring program to better accomplish the goals stated above?

(4) 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?

In 2010, the panel members provided general recommendations that were applicable to all monitoring plans from all seismic activities during that year in section 3 of the report and recommendations that were specific to ION's in-ice seismic survey 4MP in section 4.1.

In 2011, the panel members provided general recommendations that were applicable to all monitoring plans from all seismic activities during that year in section 4 of the report and recommendations that were specific to ION's in-ice seismic survey 4MP in section 5.2.

NMFS reviewed the reports and evaluated all recommendations made by the panel. NMFS determined that there were several measures that ION could incorporate into its 2012 in-ice seismic survey monitoring plan. Additionally, there were 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 2012 in-ice season due to technical issues (see below). While it may not be possible to implement those changes this year, NMFS believes that they are worthwhile and appropriate suggestions that may require additional technology advancement for them to be implemented, and ION should consider incorporating them into future monitoring plans should ION decide to apply for IHAs in the future.

The following subsections lay out measures from the panel reports that NMFS recommended for implementation as part of the 2012 in-ice seismic survey by ION and those that are recommended for future programs.

Recommendations for Inclusion in the 2012 4MP and IHA

Section 3.3 of the 2010 panel report contains several recommendations regarding PSOs, which were also included in a general list in the 2011 panel report. NMFS agreed that ION should incorporate these measures:

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

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

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

• 'Big eye' binoculars (*e.g.,* 25 x 150 power) should be used from high perches on large, stable platforms. They are most useful for monitoring impact zones that extend beyond the effective line of sight. With two or three observers on watch, the use of big eyes should be paired with searching by naked eye, the latter allowing visual coverage of nearby areas to detect marine mammals. When a single observer is on duty, the observer should follow a regular schedule of shifting between searching by naked-eye, low-power binoculars, and big-eye binoculars based on the activity, the environmental conditions, and the marine mammals of concern.

• Observers should use the best possible positions for observing (*e.g.,* outside and as high on the vessel as possible), taking into account weather and other working conditions.

• Whenever possible, new observers should be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations. If there are Alaska Native MMOs, the MMO training that is conducted prior to the start of the survey activities should be conducted with both Alaska Native MMOs and biologist MMOs being trained at the same time in the same room. There should not be separate training courses for the different MMOs.

In Section 3.4 of the 2010 panel report, panelists recommend collecting some additional data to help verify the utility of the ''ramp-up'' requirement commonly contained in IHAs. To help evaluate the utility of ramp-up procedures, NMFS recommends that observers be required to record, analyze, and report their observations during any ramp-up period. NMFS also supports the inclusion of specific studies using multiple types of monitoring (visual, acoustic, tagging) to evaluate how marine mammals respond to increasing received sound levels. Such information should provide useful evidence as to whether ramp-up procedures are an effective form of mitigation.

In the same section of the 2010 report, panelists recommend collecting data to evaluate the efficacy of using FLIR vs. night-vision binoculars. The panelists note that while both of these devices may increase detection capabilities by PSOs of marine mammals, the reliability of these technologies should be tested under appropriate conditions and their efficacy evaluated. NMFS recommends that ION design a study using both FLIR and night-vision binoculars and collect data on levels of detection of marine mammals using each type of device.

Among other things, Section 3.5 of the 2010 panel report recommends recording visibility data because of the concern that the line-of-sight distance for observing marine mammals is reduced under certain conditions. PSOs should ''carefully document visibility during observation periods so that total estimates of take can be corrected accordingly''.

Section 4.1 of the 2010 panel report contained recommendations specific to ION's 2010 2D marine seismic survey monitoring plan, which were also relevant to ION's 2012 4MP. NMFS worked with ION and decided that some of the measures presented in this section of the report, such as supporting overwintering buoy studies and coordinating in conducting tagging studies using satellite linked telemetry, were not ready for ION's to implement for its 2010 season operations, but are feasible for its 2012 season as ION has worked to make the necessary preparations over the past two years. In addition, the following recommendations will also be implemented for the 2012 season:

• Conduct sound source verification measurements to verify calculated exclusion zones to account for possible sound channels in deeper water.

• Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, the company's activity at the time, each animal's response, and any adjustments made to operating procedures. Provide all spatial data on charts (always including vessel location).

• Make all data available in the report or (preferably) electronically for integration with data from other companies.

• Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

NMFS spoke with ION about the inclusion of these recommendations into the 2012 4MP and IHA. ION indicated to NMFS that they will incorporate these recommendations into the 4MP, and NMFS will make several of these recommendations requirements in any issued IHA.

Section 4.3 of the 2011 report contains several recommendations regarding PSOs. NMFS agreed that the following measures should be incorporated into the 2012 4MP.

• PSOs record additional details about unidentified marine mammal sightings, such as ''blow only'', mysticete with (or without) a dorsal fin, ''seal splash'', etc. That information should also be included in 90-day and final reports.

In Section 4.7 of the 2011 panel report, panelists included a section regarding the need for a more robust and comprehensive means of assessing the collective or cumulative impact of many of the varied human activities that contribute noise into the Arctic environment. Specifically, for data analysis and integration, the panelists recommended, and NMFS agrees, that the following recommendations be incorporated into the 2012 program:

• 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.

• To help evaluate the effectiveness of PSOs and more effectively estimate take, reports should include sightability curves (detection functions) for distance-based analyses.

• To better understand the potential effects of oil and gas activities on marine mammals and to facilitate integration among companies and other researchers, the following data should be obtained and provided electronically in the final and comprehensive reports:

○ The location and time of each aerial or vessel-based sighting or acoustic detection;

○ Position of the sighting or acoustic detection relative to ongoing operations (*i.e.,* distance from sightings to seismic operation, drilling ship, support ship, etc.), if known;

○ The nature of activities at the time (*e.g.,* seismic on/off);

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

○ Any adjustments made to operating procedures.

In Section 4.9 of the 2011 panel report, the panelists discussed improving take estimates and statistical inference into effects of the activities. NMFS agreed that the following measures should be incorporated into the 2012 4MP:

• Reported results from all hypothesis tests should include estimates of the associated statistical power.

• 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.

Section 5.2 of the 2011 report contained recommendations specific to ION's 2011 2D seismic survey monitoring plan. Of the recommendations presented in this section, NMFS determined that the following should be implemented for the 2012 season:

• ION should test thermal imaging technologies during the proposed activities.

• Airguns should be turned off for two shots (*i.e.,* 60 seconds) to provide sufficient time to record the background noise associated with the vessels.

• ION should deploy overwintering acoustic recorders within their survey area during their eastward transit across the Alaskan Beaufort to the Canadian Beaufort Sea early in the summer. The recorders would monitor sounds during the summer, the seismic shoot, and over the winter. ION should contract someone to return in 2012 (2013 in the case that the seismic survey is delayed to 2012) to retrieve the instruments and analyze the data. These acoustic data would provide some true baseline information to compare the occurrence, distribution, and behavior of marine mammals at times when ION's activities are occurring and when they are absent. To accomplish this, ION should present a plan for an acoustic monitoring program to a NMFS-approved expert for review. The plan should consider the best placement of the instruments relative to ION's proposed activities, the expected distribution and gradients in marine mammal distribution, and other existing overwintering recorders. There are relatively few data on the distribution and relative abundance of marine mammals in the Beaufort Sea during ION's planned seismic survey.

• The report should clearly compare authorized takes to the level of actual estimated takes.

• Sightability curves (detection functions) for PSOs should be provided.

In addition, the panelists included a list of general recommendations from the 2010 Peer-review Panel Report to be implemented by operators in their 2011 open-water season activities. NMFS agreed that the following recommendations should be implemented in ION's 2012 monitoring plan (only those not mentioned previously in this document are noted here):

• Sightings should be entered and archived in a way that enables immediate geospatial depiction to facilitate operational awareness and analysis of risks to marine mammals. Real-time monitoring is especially important in areas of seasonal migration or influx of marine mammals. Various software packages for real-time data entry, mapping, and analysis are available for this purpose.

• Whenever possible, new observers should be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

Recommendations for Inclusion in Future Monitoring Plans

Section 3.5 of the 2010 report recommends methods for conducting comprehensive monitoring of a large-scale seismic operation. One method for conducting this monitoring recommended by panel members is the use of passive acoustic devices. Additionally, Section 3.2 of the 2010 report encourages the use of such systems if aerial surveys will not be used for real-time mitigation monitoring. NMFS acknowledges that there are challenges involved in using this technology in conjunction with seismic airguns in this environment, especially in real time. However, NMFS recommends that ION work to help develop and improve this type of technology for use in the Arctic (and use it once it is available and effective), as it could be valuable both for real-time mitigation implementation, as well as for archival data collection.

The panelists also recommend adding a tagging component to monitoring plans. ''Tagging of animals expected to be in the area where the survey is planned also may provide valuable information on the location of potentially affected animals and their behavioral responses to industrial activities. Although the panel recognized that such comprehensive monitoring might be difficult and expensive, such an effort (or set of efforts) reflects the complex nature of the challenge of conducting reliable, comprehensive monitoring for seismic or other relatively-intense industrial operations that ensonify large areas of ocean.'' While this particular recommendation is not feasible for implementation in 2012, NMFS recommends that ION consider adding a tagging component to future seismic survey monitoring plans should ION decide to conduct such activities in future years.

To the extent possible, NMFS recommends implementing the recommendation contained in Section 4.1.6 of the 2010 report: ''Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.'' However, NMFS recognizes that this integration process may take time to implement. Therefore, ION should begin considering methods for the integration of the observer data now if ION intends to apply for IHAs in the future.

In Section 4.7 of the 2011 report, the panelists stated that advances in integrating data from multiple platforms through the use of standardized data formats are needed to increase the statistical power to assess potential effects. Therefore, the panelists recommended that industry examine this issue and jointly propose one or several data integration methods to NMFS at the Open Water Meeting in 2012 (in this case, at the Open Water Meeting in 2013, since ION cancelled its proposed 2011 operation). NMFS concurs with the recommendation and encourages ION to collaborate with other companies to discuss data integration methods to achieve these efforts and to present the results of those discussions at the 2013 Open Water Meeting.

Other Recommendations in the Report

The panel also made several recommendations in 2010, which were not discussed in the two preceding subsections. NMFS determined that many of the recommendations were made beyond the bounds of what the panel members were tasked to do. For example, the panel recommended that NMFS begin a transition away from using a single metric of acoustic exposure to estimate the potential effects of anthropogenic sound on marine living resources. This is not a recommendation about monitoring but rather addresses a NMFS policy issue. NMFS is currently in the process of revising its acoustic guidelines on a national scale. Section 3.7 of the 2010 report contains several recommendations regarding comprehensive ecosystem assessments and cumulative impacts. These are good, broad recommendations, however, the implementation of these recommendations would not be the responsibility solely of oil and gas industry applicants. The recommendations require the cooperation and input of several groups, including Federal, state, and local government agencies, members of other industries, and members of the scientific research community. NMFS will encourage the industry and others to build the relationships and infrastructure necessary to pursue these goals, and incorporate these recommendations into future MMPA authorizations, as appropriate. Section 3.8 of the 2010 report makes a recommendation regarding data sharing and reducing the duplication of seismic survey effort. While this is a valid recommendation, it does not relate to monitoring or address any of the six questions which the panel members were tasked to answer.

For some of the recommendations, NMFS determined that additional clarification was required by the panel members before NMFS could determine whether or not applicants should incorporate them into the monitoring plans. NMFS asked for additional clarification on some of the recommendations regarding data collection and take estimate calculations. In addition, NMFS asked the panel members for clarification on the recommendation contained in Section 3.6 of the 2010 report regarding baseline studies.

Reporting Measures

Reporting

(1) SSV Report

A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190-, 180-, 160-, and 120-dB re 1 μPa (rms) radii of the airgun arrays will be submitted within 120 hr after collection and analysis of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the marine survey activities.

(2) Field Reports

Throughout the survey program, the observers will prepare a report each day or at such other intervals as the IHA may specify (if issued), or ION may require summarizing the recent results of the monitoring program. The field reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS and to the survey operators.

(3) Technical Reports

The results of the vessel-based monitoring, including estimates of ''take by harassment'', will be presented in the 90-day and final technical reports. Reporting will address the requirements established by NMFS in the IHA (if issued). The technical report will include:

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

(b) Methods, results, and interpretation pertaining to all acoustic characterization work and vessel-based monitoring;

(c) Analyses of the effects of various factors influencing detectability of marine mammals including sea state, number of observers, and fog/glare;

(d) Species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover; and

(e) Analyses of the effects of survey operations:

• Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
• 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''.

(4) Notification of Injured or Dead Marine Mammals

In addition to the reporting measures proposed by ION, NMFS will require that ION notify NMFS' Office of Protected Resources and NMFS' Stranding Network of sighting an injured or dead marine mammal in the vicinity of marine survey operations. Depending on the circumstance of the incident, ION shall take one of the following reporting protocols when an injured or dead marine mammal is discovered in the vicinity of the action area.

(a) In the unanticipated event that survey operations clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury, serious injury or mortality (*e.g.,* ship-strike, gear interaction, and/or entanglement), ION shall immediately cease survey operations and immediately report the incident to the Supervisor of Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinators. The report must include the following information:

(i) Time, date, and location (latitude/longitude) of the incident;
(ii) The name and type of vessel involved;
(iii) The vessel's speed during and leading up to the incident;
(iv) Description of the incident;
(v) Status of all sound source use in the 24 hours preceding the incident;
(vi) Water depth;
(vii) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);
(viii) Description of marine mammal observations in the 24 hours preceding the incident;
(ix) Species identification or description of the animal(s) involved;
(x) The fate of the animal(s); and
(xi) Photographs or video footage of the animal (if equipment is available).

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

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

(c) In the event that ION discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (if issued) (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ION shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinators, within 24 hours of the discovery. ION shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. ION can continue its operations under such a case.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here (military readiness activities), 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]. For the most part, only take by Level B behavioral harassment is anticipated as a result of the proposed marine seismic survey. However, due to the limited effectiveness of marine mammal monitoring during ice cover and in darkness, NMFS has preliminarily determined that Level A takes of a few individuals of marine mammals could occur if the animals remain undetected within the exclusion zones for a prolonged period of time. Although NMFS believes this is not very likely, NMFS is proposing to authorize limited takes from Level A harassment in order to address the uncertainty regarding the effectiveness of the proposed monitoring measures in these conditions. Anticipated impacts to marine mammals are associated with noise propagation from the seismic airgun(s) and the icebreaking used during the seismic 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 marine survey programs might include one or more of the following: tolerance; masking of natural sounds; behavioral disturbance; non-auditory physical effects; and, at least in theory, temporary or permanent hearing impairment (Richardson *et al.* 1995). As discussed earlier in this document, the most common impact will likely be from behavioral disturbance, including avoidance of the ensonified area or changes in speed, direction, and/or diving profile of the animal.

NMFS uses the 160 dB and 120 dB re 1 μPa (rms) isopleths to indicate the onset of Level B harassment by seismic airgun impulses and by icebreaking noises, respectively. ION provided calculations for the 160-dB and 120-dB isopleths produced by these active acoustic sources and then used those isopleths to estimate takes by harassment. NMFS used the calculations to make preliminary findings under the MMPA. ION provided a full description of the methodology used to estimate takes by harassment in its IHA application (see **ADDRESSES**), which is also described in the following sections.

ION has requested an authorization to take ten marine mammal species by Level B harassment. These ten marine mammal species are: beluga whale, harbor porpoise, bowhead whale, gray whale, humpback whale, minke whale, bearded seal, ringed seal, spotted seal, and ribbon seal. However, NMFS does not anticipate that humpback whales are likely to be encountered during the season of ION's icebreaking seismic survey. Therefore, NMFS determined that only nine of the species could be affected and potentially taken by harassment. In addition, although unlikely, NMFS determined that Level A takes of beluga whales, bowhead whales, and ringed seals could also occur, as the proposed monitoring and mitigation measures may not be 100% effective due to ice coverage and long periods of darkness.

Basis for Estimating ''Take by Harassment''

As stated previously, it is current NMFS practice to estimate take by Level A harassment for received levels above 180 dB re 1μPa (rms) for cetaceans and 190 dB re 1μPa (rms) for pinnipeds, and take by Level B harassment for all marine mammals under NMFS jurisdiction by impulse sounds at a received level above 160 dB re 1μPa (rms) and by non-impulse sounds at a received level above 120 dB re 1μPa (rms). However, not all animals are equally affected by the same received noise levels and, as described earlier, in most cases marine mammals are not likely to be taken by Level A harassment (injury) when exposed to received levels higher than 180 dB for a brief period of time.

For behavioral harassment, marine mammals will likely not show strong reactions (and in some cases any reaction) until sounds are much stronger than 160 or 120 dB (for impulse and continuous sounds, respectively). Southall *et al.* (2007) provide a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall *et al.* (2007)). Tables 7, 9, and 11 in Southall *et al.* (2007) outline the numbers of low-frequency cetaceans, mid-frequency cetaceans, and pinnipeds in water, respectively, reported as having behavioral responses to multi-pulses in 10-dB received level increments. These tables illustrate that the more severe reactions did not occur until sounds were much higher than 160 dB re 1μPa (rms).

Anticipated takes would include ''takes by harassment'' involving temporary changes in behavior (Level B harassment) and TTS (Level B harassment). NMFS does not consider injury (Level A harassment) to be likely, however, due to the limited effectiveness of monitoring and mitigation measures for animals undetected under the ice and/or during the long periods of darkness, a small amount of Level A harassment takes are also proposed to be authorized. The sections below describe methods used to estimate ''take by harassment'' and present estimates of the numbers of marine mammals that might be affected during the proposed seismic survey in the U.S. Beaufort Sea. The estimates are based on data obtained during marine mammal surveys in the Beaufort Sea and on estimates of the sizes of the areas where effects could potentially occur. In some cases, these estimates were made from data collected from regions and habitats that differed from the proposed project area. Adjustments to reported population or density estimates were made on a case by case basis to account for differences between the source data and the available information on the distribution and abundance of the species in the project area. This section provides estimates of the number of potential ''exposures'' to impulsive sound levels ≥160 dB re 1 μPa (rms), non-pulse sound levels ≥120 dB (rms) from icebreaking, and also includes estimates of exposures to ≥180 dB (rms) for cetaceans and ≥190 dB (rms) for seals.

Although several systematic surveys of marine mammals have been conducted in the southern Beaufort Sea during spring and summer, few data (systematic or otherwise) are available on the distribution and numbers of marine mammals during the early winter period of this survey, particularly in the northern Beaufort Sea. The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection. There is some uncertainty about how representative those data are and the assumptions used below to estimate the potential ''take by harassment''. However, the approach used here is accepted by NMFS as the best available at this time. The following estimates are based on a consideration of the number of marine mammals that might be disturbed appreciably by ~7,250 line kilometers (4,505 line miles) of seismic surveys across the Beaufort Sea and, to a lesser extent, the northern Chukchi Sea.

Marine Mammal Density Estimates

This section describes the estimated densities of marine mammals that may occur in the survey area. The area of water that may be ensonified to various levels is described below in the section *Potential Number of ''Takes by Harassment.''* Although a marine mammal may be exposed to icebreaking sounds >120 dB (rms) or airgun sounds >160 dB (rms), this does not mean that it will *actually* exhibit a disruption of behavioral patterns in response to the sound source. Rather, the estimates provided here are simply the best estimates of the number of animals that potentially could have a behavioral modification due to the noise. However, not all animals react to sounds at this low level, and many will not show strong reactions (and in some cases any reaction) until sounds are much stronger. There are several variables that determine whether or not an individual animal will exhibit a response to the sound, such as the age of the animal, previous exposure to this type of anthropogenic sound, habituation, etc.

The survey has been designed to minimize interactions with marine mammals by planning to conduct the work at times and in areas where the relative density of marine mammals is expected to be quite low. The survey will begin in offshore waters (≤1,000 m [3,281 ft] deep) of the eastern U.S. Beaufort Sea (east survey area) in early October. Weather and ice permitting, the waters <1,000 m (3,281 ft) deep will not be surveyed until mid-October and thereafter, in order to avoid migrating bowhead whales. The western U.S. Beaufort Sea and north-eastern Chukchi Sea (west survey area) is not expected to be surveyed until late October through December.

Separate densities were calculated for habitats specific to cetaceans and pinnipeds. For cetaceans, densities were estimated for areas of water depth <200 m (656 ft), 200–1,000 m (656–3,281 ft), and >1,000 m (3,281 ft), which approximately correspond to the continental shelf, the continental slope, and the abyssal plain, respectively. Separate densities of both cetacean and pinnipeds were also estimated for the east and west survey areas within each water depth category. However, pinniped densities in the west survey area and <200 m (656 ft) water depth category were further sub-divided into <35 m (115 ft) and 35–200 m (115–656 ft) depth categories. This was done because the west survey area is not expected to be surveyed until November–December, and based on historic sea ice data (NOAA National Ice Center, available online at *www.natice.noaa.gov*), it is expected that substantial amounts of sea ice, including shorefast ice, will be present in the west survey area at that time. Past studies have found that seal densities in ice-covered areas of the Beaufort Sea are different where water depths are <35 m (115 ft) and >35 m (Moulton *et al.,* 2002; Frost *et al.,* 2004); therefore, densities were calculated separately for these water depths. The north-eastern Chukchi Sea is composed of mostly continental shelf waters between 30 m (98 ft) and 200 m (656 ft) in depth, so only a single density estimate for each marine mammal species was used in that area. Since most marine mammals will be continuing their southerly migration in November and early December, the same density estimates for continental shelf waters in the west survey area of the Beaufort Sea were used in the Chukchi Sea. When the seismic survey area is on the edge of the range of a species at this time of year, it is assumed that the average density along the seismic trackline will be 10% (0.10×) the density determined from available survey data within the main range. Density estimates for the Chukchi Sea during the period of November–December were taken from the west survey density estimates at the appropriate depth.

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% probability of sighting an animal that is present along the survey trackline. Some sources used below took account of one or both of these correction factors in reporting densities. When these factors had not been accounted for, the best available correction factors from similar studies and/or species were applied to reported results. Details regarding the application of correction factors are provided below for each species.

(1) Cetaceans

Beluga Whales: Beluga density estimates were calculated based on aerial survey data collected in October in the eastern Alaskan Beaufort Sea by the NMML (as part of the Bowhead Whale Aerial Survey Project (BWASP) program funded by BOEM) in 2007–2010. They reported 31 sightings of 66 individual whales during 1,597 km (992 mi) of on-transect effort over waters 200–2,000 m (656–6,562 ft) deep. An f(0) value of 2.326 was applied and it was calculated using beluga whale sightings data collected in the Canadian Beaufort Sea (Innes *et al.* 2002). A g(0) value of 0.419 was used that represents a combination of ga(0) = 0.55 (Innes *et al.,* 2002) and gd(0) = 0.762 (Harwood *et al.,* 1996). The resulting density estimate (0.1169 individuals/km^2; Table 2 in this document) was applied to areas of 200–1,000 m (656 –3,281 ft). There were 3 sightings of 4 individual beluga whales during 7,482 km (4,649 mi) of on-transect effort over waters 0–200 m (0–656 ft) deep during this same time period. Using the same f(0) and g(0) values from above, the resulting density estimate for continental shelf waters (0–200 m deep) is 0.0015 individuals/km^2 (Table 2 in this document). The density estimate for waters >1000 m (3,281 ft) deep was estimated as 40% of the 200–1,000 m (656–3,281 ft) density based on the relative number of sightings in the two water depth categories. For all water depth and survey area categories, the maximum beluga density estimates represent the mean estimates multiplied by four to allow for chance encounters with unexpected large groups of animals or overall higher densities than expected.

Beluga density estimates for the west survey area, which is planned to be surveyed beginning in November, represent the east survey area estimates multiplied by 0.1 because the Beaufort Sea and north-eastern Chukchi Sea is believed to be at the edge of the species' range in November–December. Belugas typically migrate into the Bering Sea for the winter (Allen and Angliss, 2011) and are not expected to be present in the study area in high numbers in November–December. Satellite tagging data support this and indicate belugas migrate out of the Beaufort Sea in the

October–November period (Suydam *et al.,* 2005).

Bowhead Whales: Bowhead whale density estimates were calculated based on aerial survey data collected in the Beaufort Sea as part of the BWASP program funded by BOEM. The average density estimate was based on surveys in October 2007–2010 and the maximum density estimate was based on surveys conducted in October 1997–2004. The earlier data were used to calculate the maximum estimate because they include some years of unusually high numbers of bowhead sightings in the western Alaskan Beaufort Sea at that time of year. The 2007–2010 data included 25 on-transect sightings collected during 7,482 km (4,649 mi) of effort over waters 0–200 m (0–656 ft) deep in the eastern Alaskan Beaufort Sea. The 1997–2004 data included 147 on-transect sightings of 472 individual whales collected during 20,340 km (12,639 mi) of effort over waters 0–200 m (0–656 ft) deep in the eastern Alaskan Beaufort Sea. An f(0) correction factor of 2.33 used in the density calculation was the result of a weighted average of the f(0) values applied to each of the flights (Richardson and Thomson, 2002). The multiplication of ga(0) = 0.144 and gd(0) = 0.505 correction factors reported in Richardson and Thomson (2002) gave the g(0) value of 0.0727 used in the density calculation. The resulting density estimates (0.0942 whales/km^2 and 0.3719 whales/km^2) represent the average and maximum densities, respectively for October for areas of <200 m (656 ft) water depth, and are referred to below as the reference density for bowhead whales.

Because bowhead whale density is typically higher in continental shelf waters of the Beaufort Sea in early October, the survey has been planned to start in the eastern U.S. Beaufort Sea in waters deeper than 1,000 m (3,281 ft; ice conditions permitting), where bowhead density is expected to be much lower. Survey activity in shallower waters will proceed from east to west starting later in October as bowhead whales migrate west out of the Beaufort Sea. The nearshore lines in the east survey area will be surveyed during late October. Bowhead density in the east survey area in waters <200 m (656 ft) deep was estimated by taking ten percent of the reference density above (Table 2 in this document). This adjustment was based on data from Miller *et al.* (2002) that showed a ~90% decrease in bowhead whale abundance in the eastern Alaskan Beaufort Sea from early to late October.

Bowhead whale densities in intermediate (200–1,000 m [656–3,281 ft]) and deep (≤1,000 m [3,281 ft]) water depths in the east survey area are expected to be quite low. Ninety-seven percent of sightings recorded by MMS aerial surveys 1997–2004 occurred in areas of water depth <200 m (656 ft) (Treacy, 1998, 2000, 2002a, 2000b; Monnett and Treacy, 2005). Therefore, density estimates for areas of water depth 200–1,000 m (656–3,281 ft) were estimated to be ~3% of the values for areas with depth <200 m (656 ft). This is further supported by Mate *et al.* (2000), who found that 87% of locations from satellite-tagged bowhead whales occurred in areas of water depth <100 m (328 ft). In areas with water depth >1,000 m (3,281 ft), ~4,225 km (2,625 mi) of aerial survey effort occurred during October 1997–2004; however no bowhead sightings were recorded. The effort occurred over eight years, so it is unlikely that this result would have been influenced by ice cover or another single environmental variable that might have affected whale distribution in a given year. Therefore, a minimal density estimate (0.0001 whales/km^2) was used for areas with water depth >1,000 m (3,281 ft).

Several sources were used to estimate bowhead whale density in the west survey area, including the north-eastern Chukchi Sea, which is expected to be surveyed beginning in late October or early November. Mate *et al.* (2000) found that satellite-tagged bowhead whales in the Beaufort Sea travelled at an average rate of 88 km (55 mi) per day. At that rate, an individual whale could travel across the extent of the east survey area in four days and across the entire east-west extent of the survey area in ten days, if it did not stop to feed during its migration, as bowhead whales have been observed to do earlier in the year (Christie *et al.,* 2010). Also, Miller *et al.* (2002) presented a 10-day moving average of bowhead whale abundance in the eastern Beaufort Sea using data from 1979–2000 that showed a decrease of ~90% from early to late October. Based on these data, it is expected that almost all whales that had been in the east survey area during early October would likely have migrated beyond the survey areas by November–December. In addition, kernel density estimates and animal tracklines generated from satellite-tagged bowhead whales, along with acoustic monitoring data, suggest that few bowhead whales are present in the proposed survey area in November (near Point Barrow), and no whales were present in December (ADFG, 2010; Moore *et al.,* 2010). Therefore, density estimates for the <200 m (656 ft) and 200–1,000 m (656–3,281 ft) water depth categories in the west survey area were estimated to be one tenth of those estimates for the east survey area. Minimal density estimates (0.0001 whales/km^2) were used for areas of water depth >1,000 m (3,281 ft).

Other Cetaceans: Other cetacean species are not expected to be present in the area at the time of the planned survey. These species, including humpback and fin whales, typically migrate during autumn and are expected to be south of the proposed survey area by the October–December period. Gray whales have been detected near Point Barrow during the period of the proposed project, and even throughout the winter (Moore *et al.,* 2006; Stafford *et al.,* 2007). Authorization for minimal takes of other cetacean species that are known to occur in the Beaufort Sea during the summer have been requested in case of a chance encounter of a few remaining individuals.

TABLE 2—EXPECTED DENSITIES OF CETACEANS IN THE ARCTIC OCEAN IN OCTOBER–DECEMBER BY WATER DEPTH AND SURVEY AREA

Species	<200 m	200–1,000 m	>1,000 m
Beaufort East Survey Area:			
Beluga whale	0.0015	0.1169	0.0468
Harbor porpoise	0.0001	0.0001	0.0001
Bowhead whale	0.0094	0.0028	0.0001
Gray whale	0.0001	0.0001	0.0001
Minke whale	0.0001	0.0001	0.0001
Beaufort West Survey Area:			
Beluga whale	0.0002	0.0117	0.0047
Harbor porpoise	0.0001	0.0001	0.0001
Bowhead whale	0.0009	0.0003	0.0001

TABLE 2—EXPECTED DENSITIES OF CETACEANS IN THE ARCTIC OCEAN IN OCTOBER–DECEMBER BY WATER DEPTH AND SURVEY AREA—Continued

Species	<200 m	200–1,000 m	>1,000 m
Gray whale	0.0001	0.0001	0.0001
Minke whale	0.0001	0.0001	0.0001
Chukchi Survey Area:			
Beluga whale	0.0002		
Harbor porpoise	0.0001		
Bowhead whale	0.0009		
Gray whale	0.0001		
Minke whale	0.0001		

(2) Pinnipeds

In polar regions, most pinnipeds are associated with sea ice, and typical census methods involve counting pinnipeds when they are hauled out on ice. In the Beaufort Sea, surveys typically occur in spring when ringed seals emerge from their lairs (Frost *et al.,* 2004). Depending on the species and study, a correction factor for the proportion of animals hauled out at any one time may or may not have been applied (depending on whether an appropriate correction factor was available for the particular species and area). By applying a correction factor, the total density of the pinniped species in an area can be estimated. Only the animals in water would be exposed to the pulsed sounds from the airguns; however, densities that are presented generally represent either only the animals on the ice or all animals in the area. Therefore, only a fraction of the pinnipeds present in areas where ice is present (and of sufficient thickness to support hauled-out animals) would be exposed to seismic sounds during the proposed seismic survey. Individuals hauled out on ice in close proximity to the vessels are likely to enter the water as a reaction to the passing vessels, and the proportion that remain on the ice will likely increase with distance from the vessels.

Ringed Seals: Ringed seal density for the east survey area for waters <1,000 m (3,281 ft) deep was estimated using vessel-based data collected in the Beaufort Sea during autumn (Sep–Oct) 2006–2008 and reported by Savarese *et al.* (2010; Table 3 in this document). Correction factors for sightability and availability were used when the authors calculated the estimates, so no further adjustments were required. For the east survey area for waters >1,000 m (3,281 ft) deep, few data on seal distribution are available. Harwood *et al.* (2005) recorded a ringed seal sighting in the Beaufort Sea in an area where water depth was >1,000 m (3,281 ft) in September–October 2002 during an oceanographic cruise. It is therefore possible that ringed seals would occur in those areas, and their presence would likely be associated with ephemeral prey resources. If a relatively warm surface eddy formed that concentrated prey in offshore areas at depths that would be possible for ringed seals to access, it is possible that seals would be attracted to it. A warm eddy was found in the northern Beaufort Sea in October 2002 in an area where water depth was >1,000 m (3,281 ft) (Crawford, 2010), so it is possible that such an oceanographic feature might develop again and attract seals offshore. However, it is unclear whether such a feature would attract many seals, especially since the marine mammal observers present on the ship in 2002 did not observe very many seals associated with the offshore eddy. In the absence of standardized survey data from deep-water areas, but with available data suggesting densities are likely to be quite low, minimal density estimates (0.0001 seals/km^2) were used in areas where water depth is >1,000 m (3,281 ft). For all water depth categories in the east survey area, the maximum ringed seal density was assumed to be the mean estimate multiplied by four to allow for chance encounters with unexpected large groups of animals or overall higher densities than expected.

Habitat zones and associated densities were defined differently in the west survey area, which will be surveyed in November–December, because more ice is expected to be encountered at that time than in October (NOAA National Ice Center: *www.natice.noaa.gov*). The density estimates for the west survey area were calculated using aerial survey data collected by Frost *et al.* (2004) in the Alaskan Beaufort Sea during the spring. A g(0) correction factor of 0.60 from tagging data reported by Bengtson *et al.* (2005) was used to adjust all density estimates from Frost *et al.* (2004) described below. Seal distribution and density in spring, prior to breakup, are thought to reflect distribution patterns established earlier in the year (*i.e.,* during the winter months; Frost *et al.,* 2004). Density estimates were highest (1.00–1.33 seals/km^2) in areas of water depth 3–35 m (10–115 ft), and decreased (0–0.77 seals/km^2) in water >35 m (115 ft) deep. The mean density estimate used for areas with water depth <35 m (Table 4 in this document) was estimated using an average of the pack ice estimates modeled by Frost *et al.* (2004). The maximum estimate for the same area is the maximum observed density for areas of water depth 3–35 m (10–115 ft) in Frost *et al.* (2004). The mean density estimate used for areas with 35–200 m (115–656 ft) water depth is the modeled value for water depth >35 m (115 ft) from Frost *et al.* (2004). The maximum estimate is the maximum observed density for areas with >35 m (115 ft) water depth in Frost *et al.* (2004). Because ringed seal density tends to decrease with increasing water depth (Moulton *et al.,* 2002; Frost *et al.,* 2004), ringed seal density was estimated to be minimal in areas of >200 m (656 ft) water depth.

In the Chukchi Sea, ringed seal densities were taken from offshore aerial surveys of the pack ice zone conducted in spring 1999 and 2000 (Bengtson *et al.,* 2005). The average density from those two years (weighted by survey effort) was 0.4892 seals/km^2. This value served as the average density while the highest density from the two years (0.8100 seals/km^2 in 1999) was used as the maximum density.

Other Seal Species: Other seal species are expected to be less frequent in the study area during the period of this survey. Bearded and spotted seals would be present in the area during summer, and possibly ribbon seals as well, but they generally migrate into the southern Chukchi and Bering seas during fall (Allen and Angliss, 2011). Few satellite-tagging studies have been conducted on these species in the Beaufort Sea, winter surveys have not been conducted, and a few bearded seals have been reported over the continental shelf in spring prior to general breakup. However, three bearded seals tracked in 2009 moved south into the Bering Sea along the continental shelf by November (Cameron and Boveng, 2009). It is possible that some individuals, bearded seals in particular, may be present in the survey area. In the absence of better information from the published literature or other sources that would indicate significant numbers of any of these species might be present, minimal density estimates were used for all areas and water depth categories for these species, with the estimates for bearded seals assumed to be slightly higher than those for spotted and ribbon seals (Tables 3 and 4 in this document).

TABLE 3—EXPECTED DENSITIES (#/KM²) OF PINNIPEDS IN THE EAST SURVEY AREA OF THE U.S. BEAUFORT SEA IN OCTOBER

Species	<200 m	200–1,000 m	>1,000 m
Ringed seal	0.0840	0.0840	0.0004
Bearded seal	0.0004	0.0004	0.0004
Spotted seal	0.0001	0.0001	0.0001
Ribbon seal	0.0001	0.0001	0.0001

TABLE 4—EXPECTED DENSITIES (#/KM²) OF PINNIPEDS IN THE BEAUFORT WEST AND CHUKCHI SURVEY AREAS OF THE ARCTIC OCEAN IN NOVEMBER–DECEMBER

Species	<35 m	35–200 m	>200 m
Beaufort West:			
Ringed seal	1.9375	1.0000	0.0004
Bearded seal	0.0004	0.0004	0.0004
Spotted seal	0.0001	0.0001	0.0001
Ribbon seal	0.0001	0.0001	0.0001
Chukchi Sea:			
Ringed seal	....	0.4892	....
Bearded seal	....	0.0004	....
Spotted seal	....	0.0001	....
Ribbon seal	....	0.0001	....

Potential Number of Takes by Level B Behavioral Harassment

Numbers of marine mammals that might be present and potentially taken are estimated below based on available data about mammal distribution and densities at different locations and times of the year as described above.

The number of individuals of each species potentially exposed to received levels ≥120 dB re 1 μPa (rms) or ≥160 dB re 1 μPa (rms), depending on the type of activity occurring, within each portion of the survey area (east and west) and water depth category was estimated by multiplying:

• The anticipated area to be ensonified to ≥120 dB re 1 μPa (rms) or ≥160 dB re 1 μPa (rms) in each portion of the survey area (east and west) and water depth category, by

• the expected species density in that time and location.

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

(1) Potential Number of Takes by Seismic Airguns at Received Levels ≥160 dB

The area of water potentially exposed to received levels of airgun sounds ≥160 dB (rms) was calculated by using a GIS to buffer the planned survey tracklines within each water depth category by the associated modeled ≥160 dB (rms) distances. The expected sound propagation from the airgun array was modeled by JASCO Applied Research (Zykov *et al.,* 2010) and is expected to vary with water depth. Survey tracklines falling within the <100 m (328 ft), 100–1,000 m (328–3,281 ft), and >1,000 m (3,281 ft) water depth categories were buffered by distances of 27.8 km (17.3 mi), 42.2 km (26.2 mi), and 31.6 km (19.6 mi), respectively. The total area of water that would be exposed to sound >160 dB (rms) on one or more occasions is estimated to be 209,752 km². A breakdown by water depth classes used in association with density estimates is presented in Table 5 in this document and Figure 2 of the IHA application.

Based on the operational plans and marine mammal densities described above, the estimates of marine mammals potentially exposed to sounds ≥160 dB (rms) are presented in Table 5 in this document. For species likely to be present, the requested numbers are calculated as described above. For less common species, estimates were set to minimal numbers to allow for chance encounters. Discussion of the number of potential exposures is summarized by species in the following subsections.

It is likely that some members of one endangered cetacean species (bowhead whale) will be exposed to received sound levels ≥160 dB (rms) unless bowheads avoid the survey vessel before the received levels reach 160 dB (rms). However, the late autumn timing and the design of the proposed survey will minimize the number of bowheads and other cetaceans that may be exposed to seismic sounds generated by this survey. The best estimates of the number of whales potentially exposed to ≥160 dB (rms) are 282 and 4,315 for bowheads and belugas, respectively (Table 5).

The ringed seal is the most widespread and abundant pinniped species in ice-covered arctic waters, and there is a great deal of variation in estimates of population size and distribution of these marine mammals. Ringed seals account for the vast majority of marine mammals expected to be encountered, and hence exposed to airgun sounds with received levels >160 dB (rms) during the proposed marine survey. It was estimated that ~60,293 ringed seals may be exposed to marine survey sounds with received levels >160 dB (rms) if they do not avoid the sound source. Other pinniped species are not expected to be present in the proposed survey area in more than minimal numbers in October–December; however, ION is requesting authorization for a small number of harassment ''takes'' of species that occur in the area during the summer months in case a few individuals are encountered (Table 5 in this document).

It should be noted that there is no evidence that most seals exposed to airgun pulses with received levels 160 dB re 1 μPa (rms) are disturbed appreciably, and even at a received level of 180 dB (rms) disturbance is not conspicuous (Harris *et al.,* 2001; Moulton and Lawson, 2002). Therefore, for seals, the estimates of numbers exposed to ≥160 dB re 1 μPa (rms) greatly exceed the numbers of seals that will actually be disturbed in any major or (presumably) biologically significant manner.

TABLE 5—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO ≥160 DB RE 1 μPA (RMS) DURING ION'S PROPOSED SEISMIC PROGRAM IN THE BEAUFORT AND CHUKCHI SEAS, OCTOBER–DECEMBER 2012

	Water depth			Total
	<200 m	200–1,000 m	>1,000 m	
Cetaceans				
Beluga whale	43	1,195	3,077	4,215
Harbor porpoise	9	2	10	21
Bowhead whale	269	3	10	282
Gray whale	9	2	10	21
Minke whale	9	2	10	21
Pinnipeds (Beaufort East)				
	<35 m	35–200 m	>200 m	
Ringed seal	1,794	805	25	2,624
Bearded seal	9	4	25	38
Spotted seal	2	1	6	9
Ribbon seal	2	1	6	9
Pinnipeds (Beaufort West & Chukchi Sea)				
Ringed seal	16,969	40,682	18	57,669
Bearded seal	4	25	18	47
Spotted seal	1	6	5	12
Ribbon seal	1	6	5	12

(2) Potential Number of Takes by Icebreaking at Received Levels ≥120 dB

As discussed above, based on available information regarding sounds produced by icebreaking in various ice regimes and the expected ice conditions during the proposed survey, vessel sounds generated during ice breaking are likely to have source levels between 175 and 185 dB re 1 μPa-m. As described above, we have assumed that seismic survey activity will occur along all of the planned tracklines shown in Figure 1 of ION's IHA application. Therefore, received levels ≥160 dB radius of 26.7–42.2 km (16.6–26.2 mi; depending on water depth) to each side of all of the survey lines was applied for the calculation. Assuming a source level of 185 dB re 1 μPa-m and using the 15logR for calculating spreading loss of acoustic intensity, icebreaking sounds may be ≥120 dB out to a maximum distance of ~21.6 km (13.4 mi). Thus, all sounds produced by icebreaking are expected to diminish below 120 dB re 1 μPa within the zone where we assume mammals will be exposed to ≥160 dB (rms) from seismic sounds. Exposures of marine mammals to icebreaking sounds with received levels ≥120 dB would effectively duplicate or ''double-count'' animals already included in the estimates of exposure to strong (≥160 dB) airgun sounds. The planned survey lines cover a large extent of the U.S. Beaufort Sea, and seismic survey activity along all those lines has been assumed in the estimation of takes. Any non-seismic periods, when only icebreaking might occur, would therefore result in fewer exposures than estimated from seismic activities.

If refueling of the *Geo Arctic* is required during the survey and the *Polar Prince* transits to and from Canadian waters to acquire additional fuel for itself, an additional ~200 km (124 mi) of transit may occur. Most of this transit would likely occur through ice in offshore waters >200 m (656 ft) in depth. For estimation purposes we have assumed 25% of the transit will occur in 200–1,000 m (656–3,281 ft) of water and the remaining 75% will occur in >1,000 m (3,281 ft) of water. This results in an estimated ~2,160 km² of water in areas 200–1,000 m (656–3,281 ft) deep and 6,487 km² in waters >1,000 m (3,281 ft) deep being ensonified to ≥120 dB by icebreaking sounds. Using the density estimates for the east survey area shown in Tables 2 and 3, the estimated exposures of cetaceans and pinnipeds are shown in Table 6 here.

TABLE 6—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO ≥120 dB RE 1 μPA (RMS) DURING ICEBREAKING ACTIVITIES ASSOCIATED WITH THE PREFERRED ALTERNATIVE FOR REFUELING DURING ION'S PROPOSED SEISMIC PROGRAM IN THE BEAUFORT SEA, OCTOBER–DECEMBER 2012

Species	Water depth		Total
	200–1,000 m	>1,000 m	
Beluga whale	253	320	573
Harbor porpoise	0	1	1
Bowhead whale	1	1	2
Gray whale	0	1	1
Minke whale	0	1	1
Ringed seal	181	3	184
Bearded seal	1	3	4
Spotted seal	0	1	1
Ribbon seal	0	1	1

If the *Polar Prince* cannot return to port via Canadian waters, then a transit of ~600 km (373 mi) from east to west across the U.S. Beaufort would be necessary. Again, it is expected that most of this transit would likely occur in offshore waters >200 m (656 ft) in depth. For estimation purposes we have assumed 25% of the transit will occur in 200–1,000 m (656–3,281 ft) of water and the remaining 75% will occur in >1,000 m (3,281 ft) of water. This results in an estimated ~3,240 km² of water in areas 200–1,000 m (656–3,281 ft) deep and 9,720 km² in waters >1,000 m (3,281 ft) deep being ensonified to ≥120 dB by icebreaking sounds within each half of the U.S. Beaufort Sea, for a total of 25,920 km² ensonified across the entire U.S. Beaufort Sea. Using the density estimates in Tables 2–3, estimated exposures of cetaceans and pinnipeds are shown in Table 7 here.

TABLE 7—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO ≥120 dB RE 1 μPA (RMS) DURING ICEBREAKING ACTIVITIES ASSOCIATED WITH THE SECONDARY ALTERNATIVE FOR REFUELING DURING ION'S PROPOSED SEISMIC PROGRAM IN THE BEAUFORT AND CHUKCHI SEAS, OCTOBER–DECEMBER 2012

Species	Water depth		Total
	200–1,000 m	>1,000 m	
Beluga whale	417	500	917
Harbor porpoise	0	2	2
Bowhead whale	1	2	3
Gray whale	0	2	2
Minke whale	0	2	2
Ringed seal	273	8	281
Bearded seal	2	8	10
Spotted seal	0	2	2
Ribbon seal	0	2	2

Potential Number of Takes by Level B TTS and Level A Harassment

As noted previously, due to the limited effectiveness of monitoring and mitigation measures for animals under ice cover and during long lowlight hours, NMFS is proposing to authorize takes of marine mammals by TTS (Level B harassment) and PTS (Level A harassment or injury) when exposed to received noise levels above 180 and 190 dB re 1 μPa (rms) for prolonged period, although this is unlikely to occur. Therefore, the result of the analysis is conservative in which animals are estimated to be affected by receiving TTS or even PTS.

The methods used below for estimating the number of individuals potentially exposed to sounds >180 or >190 dB re 1 μPa (rms) should therefore include an additional reduction to estimate the number that may incur PTS, which is presumably a Level A take. For reasons described here and further below, NMFS and ION do not anticipate that marine mammals will be injured or harmed by the proposed project.

Only two cetacean species, beluga and bowhead, are likely to be present in the Alaskan Beaufort Sea late in the survey period or where extensive ice cover is present. Gray whale vocalizations have been recorded throughout one winter (2003–2004) in the western Alaskan Beaufort Sea near Pt. Barrow (Moore *et al.,* 2006). However, the presence of gray whales in October and November in the Alaskan Beaufort Sea does not appear to be a regular occurrence or involve a significant number of animals when it does occur. NMFS therefore does not anticipate exposures of cetacean species, other than belugas or bowheads, to received sound levels ≥180 dB during periods of darkness or in areas with extensive ice cover to occur.

Beluga whales have shown avoidance of icebreaking sounds at relatively low received levels. In the Canadian Arctic, belugas showed initial avoidance of icebreaking sounds at received levels from 94–105 dB in the 20–1,000 Hz band, although some animals returned to the same location within 1–2 days and tolerated noise levels as high as 120 dB in that band (Finley *et al.,* 1990). Playback experiments of icebreaker sounds resulted in 35% of beluga groups showing avoidance at received levels between 78–84 dB in the ⅓-octave band centered at 5,000 Hz, or 8–14 dB above ambient levels (Richardson *et al.,* 1995b). Based on these results, it was estimated that reactions by belugas to an actual icebreaker would likely occur at ~10 km (6.2 mi) under similar conditions. Erbe and Farmer (2000) estimated that zones of disturbance from icebreaking sounds could extend 19–46 km (12–28.6 mi) depending on various factors. Erbe and Farmer (2000) also estimated that a beluga whale would have to remain within 2 km (1.2 mi) of an icebreaker backing and ramming for over 20 min to incur small TTS (4.8 dB), and within 120 m for over 30 min to incur more significant TTS (12–18 dB).

Aerial and vessel based monitoring of seismic surveys in the central Beaufort Sea showed significant avoidance of active airguns by belugas. Results of the aerial monitoring suggested an area of avoidance out to 10–20 km (6.2–12.4 mi) around an active seismic source with higher than expected sighting rates observed at distances 20–30 km (12.4–18.6 mi) from the source. The nearest aerial ''transect'' beluga sighting during seismic activity was at a distance of 7.8 km (4.8 mi). Only seven beluga sightings were recorded from the survey vessel during the entire study, three of which occurred during airgun activity. Two of the seismic period sightings were made at the beginning of active airgun periods and the other was during seismic testing of a limited number of guns. These sightings occurred at distances between 1.54 km and 2.51 km from the vessel. Similarly, few beluga whales were observed near seismic surveys in the Alaskan Beaufort Sea in 1996–1998 (Richardson 1999), although the beluga migration corridor is typically well offshore of where most of the seismic survey occurred. Observers on seismic and associated support vessels operating in the Alaskan Beaufort Sea during 2006–2008 seasons reported no beluga sightings during seismic or non-seismic periods, suggesting avoidance of both seismic and vessel sounds (Savarese *et al.,* 2010). No mitigation measures during seismic operations (power down or shut down of airgun arrays) have been required as a result of beluga sightings during surveys in the Chukchi or Beaufort seas in 2006–2009 (Ireland *et al.,* 2007a, 2007b; Patterson *et al.,* 2007, Funk *et al.,* 2008, Ireland *et al.,* 2009b, Reiser *et al.,* 2010).

Based on the reported avoidance of vessel, icebreaking, and seismic sounds by beluga whales, and the low and seasonally decreasing density during the time of the proposed survey, the likelihood of beluga whales occurring within the ≥180 dB zone during the proposed project is extremely low. A cautionary estimate that assumes 10% of belugas will show no avoidance of the 180 dB zone results in an estimate of 23 beluga whales exposed to sounds ≥180 dB (based on the densities described above and the area of water that may be ensonified to ≥180 dB) during the proposed project.

Bowhead whales have shown similar avoidance of vessel and seismic sounds. Less information is available regarding avoidance of icebreaking sounds; however, avoidance of the overall activity was noted during intensive icebreaking around drill sites in the Alaskan Beaufort Sea in 1992. Migrating bowhead whales appeared to avoid the area of drilling and icebreaking by ~25 km (15.5 mi) (Brewer *et al.,* 1993). Also, monitoring of drilling activities in a previous year, during which much less icebreaking occurred, showed avoidance by migrating bowheads out to ~20 km (12.4 mi). Therefore, the relative influence of icebreaking versus drilling sounds is difficult to determine.

Similarly, migrating bowheads strongly avoided the area within ~20 km (12.4 mi) of nearshore seismic surveys, and less complete avoidance extended to ~30 km (18.6 mi) (Miller *et al.,* 1999). Only 1 bowhead was observed from the survey vessel during the three seasons (1996–1998) when seismic surveys continued into September. Bowheads not actively engaged in migration have shown less avoidance of seismic operations. During seismic surveys in the Canadian Beaufort Sea in late August and early September bowhead whales appeared to avoid an area within ~2 km (1.2 mi) of airgun activity (Miller and Davis, 2002) and sightings from the survey vessel itself were common (Miller *et al.,* 2005). Vessel-based sightings showed a statistically significant difference of ~600 m (1,969 ft) in the mean sighting distances of bowheads (relative to the survey vessel) between periods with and without airgun activity. This, along with significantly lower sighting rates of bowhead whales during periods of airgun activity, suggests that bowheads still avoided close approach to the area of seismic operation (Miller and Davis, 2002). Results from vessel-based and aerial monitoring in the Alaskan Beaufort Sea during 2006–2008 were similar to those described above (Funk *et al.,* 2010). Sighting rates from seismic vessels were significantly lower during airgun activity than during non-seismic periods. Support vessels reported 12 sightings of bowhead whales in areas where received levels from seismic were ≥160 dB (Savarese *et al.,* 2010). Aerial surveys reported bowhead whales feeding in areas where received levels of seismic sounds were up to 160 dB. Bowheads were not observed in locations with higher received levels (Christie *et al.,* 2010). Based on four direct approach experiments in northern Alaskan waters, Ljungblad *et al.* (1988) reported total avoidance of seismic sounds at received sound levels of 152, 165, 178, and 165 dB.

The available information summarized above suggests that bowhead whales are very likely to avoid areas where received levels are ≥180 dB re 1 µPa (rms). Again, making a cautionary assumption that as many as 10% of bowheads may not avoid the 180 dB zone around the airguns, we calculate that 6 individuals could be exposed to ≥180 dB (based on the densities described above and the area of water that may be ensonified to ≥180 dB). During seismic surveys in the Alaskan Beaufort Sea in 2007 and 2008, 5 power downs of the full airgun array were made due to sightings of bowhead or unidentified mysticete whales (8 total individuals) within the ≥180 dB exclusion zone. These sightings occurred during >8000 km (4,971 mi) of survey effort in good conditions plus additional effort in poor conditions (Savarese *et al.,* 2010), resulting in an estimated 0.625 sightings within the 180 dB distance per 1,000 km (620 mi) of seismic activity. Even without allowance for the reduced densities likely to be encountered in October and especially November, or for the fact that observers will be on duty during all daylight hours and will call for mitigation actions if whales are sighted within or near the 180 dB distance, this rate would suggest that fewer than 8 bowheads may occur within the ≥180 dB zone during the proposed survey.

For seals (principally ringed seals), the proportion exhibiting avoidance is lower than for cetaceans, and thus the received level at which avoidance becomes evident is higher. However, some survey results have shown a statistically significant avoidance of the 190 dB re 1 µPa (rms) zone, and an assumption that numbers exposed to ≥190 dB could be calculated from ''non-seismic'' density data is not inappropriate. Using similar reasoning as described above for cetaceans, we have limited these estimates to ringed seals as the presence of other pinniped species is very unlikely during the times and locations when exposures to ≥190 dB may have an increased likelihood of occurrence.

Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of seals exposed to seismic pulses (Harris *et al.,* 2001; Moulton and Lawson, 2002). The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings averaged somewhat farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson, 2002). Also, seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. However, the avoidance movements were relatively small, on the order of 100 m (328 ft) to (at most) a few hundreds of meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by.

During more recent seismic surveys in the Arctic (2006–2009), Reiser *et al.* (2009) also reported a tendency for localized avoidance of areas immediately around the seismic source vessel along with coincident increased sighting rates at support vessels operating 1–2 km (0.62–1.2 mi) away. However, pinnipeds were sighted within the 190 dB zone around the operating airguns more frequently than were cetaceans within the 180 dB zone. Assuming that 25% of the ringed seals encountered may not avoid the 190 dB zone as the airguns approach, we calculate that ~277 individuals could be exposed to ≥190 dB (based on the densities described above and the area of water that may be ensonified to ≥190 dB). As an alternative estimate, during the same >8,000 km (4,971 mi) of monitoring effort in the Alaskan Beaufort Sea reported above regarding bowhead whales, 42 observations of seals within the 190 dB zone caused power downs of the airguns. This was ~5.25 power downs per 1,000 km (620 mi) of seismic survey effort. Even without allowance for the reduced densities of seals likely to be encountered in October–November or for the fact that observers will be on duty during all daylight hours and will call for mitigation actions if necessary, this rate would suggest that as many as 38 seals may occur within the ≥190 dB zone during the proposed survey.

However, as stated earlier, in most circumstances marine mammals would avoid areas where intense noise could cause injury, including PTS. Although approximately 23 beluga whales, 8 bowhead whales, and 38 seals (presumably all ringed seals) could theoretically be exposed to received levels above 180 dB re 1 μPa (for whales) and 190 dB re 1 μPa (for seals), most of them are likely to avoid these areas of intense noise and would not incur TTS or PTS (injury). In the unlikely case a small number of individuals animals did not avoid the intense noise, then TTS or even PTS could occur. Assuming that 10% of the individuals that were initially exposed to received levels above 180 dB re 1 μPa (for beluga and bowhead whales) and 190 dB re 1 μPa (for ringed seals) do not vacate the area, and subsequent exposure leads to some degree of PTS, then approximately 3 beluga whales, 1 bowhead whale, and 4 ringed seals could be taken by Level A harassment. However, NMFS considers this estimate to be very conservative as explained above.

Estimated Take Conclusions

Cetaceans—Effects on cetaceans are generally expected to be restricted to avoidance of an area around the seismic survey and short-term changes in behavior, falling within the MMPA definition of ''Level B harassment,'' and possibly mild TTS or PTS (which would be considered ''Level A harassment''), though not very likely.

Using the 160 dB (for pulse) and 120 dB (for non-pulse) criteria, the average estimates of the numbers of individual cetaceans exposed to sounds ≥160 dB and 120 dB re 1 μPa (rms) represent varying proportions of the populations of each species in the Beaufort Sea and adjacent waters. For species listed as ''Endangered'' under the ESA, the estimates include approximately 284 bowheads. This number is approximately 1.86% of the Bering-Chukchi-Beaufort population of >15,233 assuming 3.4% annual population growth from the 2001 estimate of >10,545 animals (Zeh and Punt 2005). For other cetaceans that might occur in the vicinity of the marine seismic survey in the Chukchi Sea, they also represent a very small proportion of their respective populations. The average estimates of the number of beluga whales, harbor porpoises, gray whales, and minke whales that might be exposed to ≥160 dB and 120 dB re 1 μPa (rms) are 5,232, 23, 23, and 23, when the secondary alternative for refueling is being considered. These numbers represent 13.33%, 0.05%, 0.12%, and 1.87% of these species' respective populations in the proposed action area. If ION selects the preferred alternative for refueling, the estimated takes for beluga would be reduced to 4,888 animals, or 12.45% of the population.

Seals—A few seal species are likely to be encountered in the study area, but ringed seal is by far the most abundant in this area. The average estimates of the numbers of individuals exposed to sounds at received levels ≥160 dB and 120 dB re 1 μPa (rms) during the proposed icebreaking seismic survey are as follows: ringed seals (60,574), bearded seals (95), spotted seals (23), and ribbon seals (23), when the secondary alternative for refueling is being considered. These numbers represent 24.33%, 0.04%, 0.04%, and 0.05% of Alaska stocks of ringed, bearded, spotted, and ribbon seals. If ION selects the preferred alternative for refueling, the estimated takes for ringed, bearded, spotted, and ribbon seals would drop to 60,477, 89, 22, and 22, respectively, which in turn represent 24.29%, 0.04%, 0.04%, 0.04% of Alaska stocks of these species.

Negligible Impact and Small Numbers Analysis and Preliminary Determination

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

Most of the takes from ION's proposed icebreaking seismic surveys are expected to be Level B behavioral harassment. It is possible, however, that TTS (Level B harassment) and even PTS (Level A harassment) could occur if monitoring measures are not effective due to extensive ice coverage and prolonged periods of darkness. Although it is possible that some individual marine mammals may be exposed to sounds from marine survey activities more than once, this is not expected to happen extensively since both the animals and the survey vessels will be moving constantly in and out of the survey areas. Therefore, the degrees of TTS and PTS, if incurred, are expected to be minor (low intensity—a few dBs of loss at certain frequencies), and the TTS is expected to be brief (minutes to hours) before full recovery. No serious injuries or mortalities are anticipated to occur as a result of the proposed seismic survey, and none are proposed to be authorized.

Of the nine marine mammal species likely to occur in the proposed marine survey area, only the bowhead whale is listed as endangered 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). There is no critical habitat designated in the U.S. Arctic for the bowhead whale. Certain stocks or populations of gray and beluga whales and spotted seals are listed as endangered or are proposed for listing under the ESA; however, none of those stocks or populations occur in the proposed activity area. On December 10, 2010, NMFS published a notice of proposed threatened status for subspecies of the ringed seal (75 FR 77476) and a notice of proposed threatened and not warranted status for subspecies and distinct population segments of the bearded seal (75 FR 77496) in the **Federal Register.** Neither of these two ice seal species is currently considered depleted under the MMPA.

Level B Behavioral Harassment

Most of the bowhead whales encountered during the summer will likely show overt disturbance (avoidance) only if they receive airgun sounds with levels ≥160 dB re 1 μPa (rms). Odontocete reactions to seismic energy 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). Both belugas and bowhead whales are expected to occur in much smaller numbers in the vicinity of the proposed seismic survey area during the proposed survey. In addition, due to the constant moving of the seismic survey vessel, the duration of the noise exposure of cetaceans to seismic impulses would be brief. For the same reason, it is unlikely that any individual animal would be exposed to high received levels multiple times.

Taking into account the mitigation measures that are planned, effects on cetaceans are generally expected to be restricted to avoidance of a limited area around the survey operation and short-term changes in behavior, falling within the MMPA definition of ''Level B harassment,'' with only limited potential occurrences of TTS (Level B harassment) and PTS (Level A harassment).

Furthermore, the estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are small percentages of the population sizes in the Bering-Chukchi-Beaufort seas, as described above.

Finally, as discussed above, since ION is not likely to start its proposed in-ice seismic survey until early October when most of the cetaceans (especially bowhead whales) have moved out of the area, the actual take numbers are expected to be much lower.

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 PSOs, non-pursuit, and shutdowns 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.

Some individual pinnipeds may be exposed to sound from the proposed marine surveys more than once during the time frame of the project. However, as discussed previously, due to the constant moving of the survey vessel, the probability of an individual pinniped being exposed multiple times is much lower than if the source is stationary. Therefore, NMFS has preliminarily determined that the exposure of pinnipeds to sounds produced by the proposed marine seismic survey in the Beaufort and Chukchi Seas is mostly expected to result in no more than Level B harassment and is anticipated to have no more than a negligible impact on the animals.

The estimated Level B behavioral takes proposed to be authorized represent up to 12.45% of the Beaufort Sea population of approximately 39,258 beluga whales (Allen and Angliss, 2010), up to 0.04% of Bering Sea stock of approximately 48,215 harbor porpoises, 0.12% of the Eastern North Pacific stock of approximately 19,126 gray whales, 1.86% of the Bering-Chukchi-Beaufort population of 15,233 individuals assuming 3.4 percent annual population growth from the 2001 estimate of 10,545 animals (Zeh and Punt, 2005), and 1.78% of the Alaska stock of approximately 1,233 minke whales. The take estimates presented for ringed, bearded, spotted, and ribbon seals represent up to 24.29, 0.04, 0.04, and 0.04 percent of U.S. Arctic stocks of each species, respectively. These estimates represent the percentage of each species or stock that could be taken by Level B behavioral harassment if each animal is taken only once. It may seem that a large number of ringed seal (up to 24.29%) would be taken as a result of the proposed seismic survey activity. It is important to note that the population densities for marine mammals within the proposed survey area are overestimated for the season of the seismic survey due to the lack of realistic data, and that the number of ringed seals that would occur in the project area during the proposed survey period is expected to be much lower. Therefore, far fewer ringed seals are actually expected to be taken as a result of ION's proposed icebreaking seismic survey in the Beaufort Sea. Furthermore, it is likely that individual animals could be taken multiple times and be counted as different individuals, thus inflating the percentage of unique individuals that would be affected. Finally, as discussed earlier, the effects to marine mammals that would result from Level B behavioral harassment are expected to be minor and brief, and mostly involve animals temporarily changing their behavior and vacating the proximity of the survey area briefly as the survey vessel and icebreaker approach. Marine mammals are expected to resume their normal activities and reoccupy the area as soon as the vessels move away. Additionally, since the proposed icebreaking seismic survey is planned outside the time when ice seals are giving birth, no impacts on pups are expected. Therefore, although the number of ringed seals that could be affected by the proposed seismic survey seems high, these effects are not expected to be biologically significant on either the individual or population level for this species. In addition, the mitigation and monitoring measures (described previously in this document) proposed for inclusion in the IHA (if issued) are expected to further reduce any potential disturbance to marine mammals.

Hearing Impairment (TTS, Level B Harassment, or PTS, Level A Harassment)

Most cetaceans (and particularly Arctic cetaceans) show relatively high levels of avoidance when received sound pulse levels exceed 160 dB re 1 μPa (rms), and it is uncommon to sight Arctic cetaceans within the 180 dB radius, especially for prolonged duration. Results from monitoring programs associated with seismic activities in the Arctic have shown significant responses by cetaceans at levels much lower than 180 dB. These results have been used by agencies to support monitoring requirements within distances where received levels fall below 160 dB and even 120 dB. Thus, very few animals would be exposed to sound levels of 180 dB re 1 μPa (rms) regardless of detectability by PSOs. Avoidance varies among individuals and depends on their activities or reasons for being in the area, and occasionally a few individual arctic cetaceans will tolerate sound levels above 160 dB. Tolerance of levels above 180 dB is infrequent, regardless of the circumstances. Therefore, a calculation of the number of cetaceans potentially exposed to >180 dB that is based simply on density would be a gross overestimate of the actual numbers exposed to 180 dB. Such calculations would be misleading unless avoidance response behaviors were taken into account to estimate what fraction of those originally present within the soon-to-be ensonified to >180 dB zone (as estimated from density) would still be there by the time levels reach 180 dB.

It is estimated that up to 1 bowhead whale and 3 beluga whales could be exposed to received noise levels above 180 dB re 1 μPa (rms), and 4 ringed seals could be exposed to received noise levels above 190 dB re 1 μPa (rms) for durations long enough to cause TTS if the animals are not detected in time to have mitigation measures implemented (or even PTS if such exposures occurred repeatedly). The potential takes of marine mammals by TTS (Level B harassment), or, potentially PTS (Level A harassment) if exposed for a long enough time or repeatedly represent 0.0068%, 0.0076%, and 0.0016% of bowhead whale, beluga whale, and ringed seal populations, respectively. None of the other species are expected to be exposed to received sound levels anticipated to cause TTS or PTS.

Marine mammals that are taken by TTS are expected to receive minor (in the order of several dBs) and brief (minutes to hours) temporary hearing impairment because (1) animals are not likely to remain for prolonged periods within high intensity sound fields, and (2) both the seismic vessel and the animals are constantly moving, and it is unlikely that the animal will be moving along with the vessel during the survey. Although repeated experience to TTS could result in PTS (injury or Level A harassment), for the same reasons discussed above, even if marine mammals experience PTS, the degree of PTS is expected to be mild, resulting in a few dB elevation of hearing threshold. Therefore, even if a few marine mammals receive TTS or PTS, the degree of these effects are expected to be minor and, in the case of TTS, brief, and are not expected to be biologically significant for the population or species.

Effects on Marine Mammal Habitat

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. For bowhead whales, the majority of the population would have migrated past many of the feeding areas of the central Beaufort Sea prior to the initiation of activities by ION.

The effects of icebreaking activity are not expected to result in significant modification to marine habitat. Although it is expected that the ice coverage would be 8/10th to 10/10th, the ice in the proposed project area is loose annual ice during the time of the proposed in-ice seismic survey activity. Therefore, ice floes being broken and pushed aside from the icebreaker are expected to rejoin behind the seismic survey path. In addition, no ice seal lairs are expected during the period of ION's proposed in-ice seismic survey in the Beaufort and Chukchi Seas.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that ION's proposed 2010 in-ice seismic survey in the Beaufort and Chukchi Seas may result in the incidental take of small numbers of marine mammals, by Level A and Level B harassment only, and that the total taking from the seismic surveys will have a negligible impact on the affected species or stocks.

Unmitigable Adverse Impact Analysis and Preliminary Determination

NMFS has preliminarily determined that ION's proposed 2010 in-ice marine seismic survey in the Beaufort and Chukchi Seas will not have an unmitigable adverse impact on the availability of species or stocks for taking for subsistence uses. This preliminary determination is supported by information contained in this document and ION's POC. ION has adopted a spatial and temporal strategy for its Beaufort and Chukchi Seas in-ice seismic survey operations that is intended to avoid subsistence activities. ION plans to start its seismic survey after the fall bowhead harvests have concluded for the communities of Kaktovik and Nuiqsut, and its seismic survey is expected to occur far offshore from regular ringed seal hunts. Although hunting may still be occurring in Barrow, ION has agreed to work in the eastern part of the survey area first so as not to overlap with hunting areas used by hunters in Barrow. The late November bowhead harvests on St. Lawrence Island should not be affected by ION's vessel transits through the Bering Strait at the conclusion of the survey in early to mid-December. No other subsistence activity is expected to occur during ION's proposed seismic survey period.

Based on the measures described in ION's POC, the proposed mitigation and monitoring measures (described earlier in this document), and the project design itself, NMFS has determined preliminarily that there will not be an unmitigable adverse impact on subsistence uses from ION's icebreaking marine seismic survey in the Beaufort and Chukchi Seas.

Proposed Incidental Harassment Authorization

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

1. This Authorization is valid from October 1, 2012, through December 15, 2012.

2. This Authorization is valid only for activities associated with in-ice seismic surveys and related activities in the Beaufort and Chukchi Seas, as indicated in Figure 1 of ION's IHA application.

3. (a) The species authorized for incidental harassment takings, Level B harassment only, are:

- Beluga whales (*Delphinapterus leucas*);
- Harbor porpoises (*Phocoena phocoena*);
- Bowhead whales (*Balaena mysticetus*);
- Gray whales (*Eschrichtius robustus*);
- Minke whales (*Balaenoptera acutorostrata*);
- Bearded seals (*Erignathus barbatus*);
- Spotted seals (*Phoca largha*);
- Ringed seals (*P. hispida*); and
- Ribbon seals (*P. fasciata*).

(b) The species authorized for incidental harassment taking, Level A harassment, are:

- One individual of bowhead whale;
- Three individuals of beluga whale; and

- Four individuals of ringed seal.

(c) The authorization for taking by harassment is limited to the following acoustic sources and from the following activities:

(i) 28 Sercel G-gun airguns, of which 26 are active with a total discharge volume of 4,450 in^3.

(ii) Individual airgun sizes range from 70 to 380 in^3.

(d) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Alaska Regional Administrator (907–586–7221) or his designee in Anchorage (907–271–3023), National Marine Fisheries Service (NMFS) and the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at (301) 427–8401, or his designee (301–427–8418).

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

5. Prohibitions

(a) The taking, by incidental harassment only, is limited to the species listed under conditions 3(a) and (b) above. The taking by serious injury or death of these species or the taking by harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

(b) The taking of any marine mammal is prohibited whenever the required source vessel protected species observers (PSOs), required by condition 7(a)(i), are not onboard in conformance with condition 7(a)(i) of this Authorization.

6. Mitigation

(a) Exclusion Zones

(i) Establish and monitor with trained Protected Species Observers (PSOs) a preliminary exclusion zone for cetaceans and pinnipeds surrounding the airgun array on the source vessel where the received level would be 180 dB (for cetaceans) and 190 dB (for pinnipeds) re 1 μPa (rms), respectively. For purposes of the sound source verification test, described in condition 7(d)(i), the modeled exclusion zones at areas of different depth are shown in Table 1 below.

TABLE 1—MARINE MAMMAL EXCLUSION ZONES FOR SPECIFIC CATEGORIES BASED ON THE WATER DEPTH

rms (dB re. 1 μPa)	Exclusion and disturbance zones (meters)		
	Less than 100 m	100 m–1,000 m	More than 1,000 m
190	600	180	180
180	2,850	660	580
160	27,800	42,200	31,600

(ii) Immediately upon completion of data analysis of the sound source verification measurements required under condition 7(d)(i) below, the new 180-dB and 190-dB re 1 μPa (rms) marine mammal exclusion zones shall be established based on the sound source verification.

(b) Speed or Course Alteration

(i) If a marine mammal (in water) is detected outside the exclusion zone and, based on its position and the relative motion, is likely to enter the exclusion zone, the vessel's speed and/or direct course shall be changed in a manner that also minimizes the effect on the planned objectives when such a maneuver is safe.

(ii) Avoid concentrations or groups of whales by all vessels in transient under the direction of ION. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

(iii) All vessels during transient shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any barge or transit vessel approaches within 1.6 km (1 mi) of observed bowhead whales, the vessel operator shall take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

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

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

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

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

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

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

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

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

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

(c) Ramp-up:

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

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

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

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

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

(d) Power-down/Shutdown:

(i) The airgun array shall 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 airgun.

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

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

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

(v) If a marine mammal on ice is detected by PSOs within the exclusion zones it will be watched carefully in case it enters the water. In the event the animal does enter the water and is within an applicable exclusion zone of the airguns during seismic operations, a power down or other necessary mitigation measures shall immediately be implemented.

(vi) Airgun activity shall not resume until the marine mammal has cleared the exclusion zone of the full array. The animal will be considered to have cleared the exclusion zone as described above under ramp up procedures.

(e) Poor Visibility Conditions:

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

(ii) 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.

(iii) Airguns shall not be fired during long transits when exploration activities are not occurring, including the common firing of one airgun (also referred to as the ''mitigation gun'' in past IHAs). This does not apply to turns when starting a new track line.

(f) Mitigation Measures for Subsistence Activities:

(i) ION shall fully implement the following measures, consistent with the 2012 Plan of Cooperation (COP), in order to avoid having an unmitigable adverse impact on the availability of marine mammal species or stocks for taking for subsistence uses:

(A) Schedule the seismic survey so that seismic operations in the eastern survey area do not begin until October 1, 2012, or the completion of Kaktovik bowhead whaling, whichever is later;

(B) Schedule the seismic survey so that seismic operations in the western survey area do not begin until completion of Barrow fall bowhead whaling (expected to be approximately November 1, 2012).

(C) Plan the survey to proceed from the eastern to western U.S. Beaufort Sea to avoid, as much as possible, any remaining migratory animals and associated subsistence activities.

(ii) ION shall maintain a Communication Center (Com Center) that is staffed 24 hours a day, 7 days a week, during the seismic survey operational window.

(iii) Vessels shall report in to the Com Center a minimum of every 6 hours and provide information about the vessel's location, speed, and direction. The Com Center shall be notified if there is any significant change in plans or any potentially unsafe or unanticipated conditions (*e.g.,* weather, ice conditions).

7. Monitoring:

(a) Daytime Vessel Monitoring:

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

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

(B) Crew leaders and most other biologists serving as observers in 2012 will be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

(C) PSOs shall complete a two or three-day training session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2012 open-water season. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs. A marine mammal observers' handbook, adapted for the specifics of the planned survey program will be reviewed as part of the training.

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

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

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

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

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

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

(ii) PSOs shall be on duty for four (4) consecutive hours or less, although more than one four-hour shift per day is acceptable, with a maximum of 12 hours of watch time per PSO.

(iii) Three PSOs shall be stationed aboard the icebreaker *Polar Prince* to take advantage of this forward operating platform and provide advanced notice of marine mammals to the PSOs on the survey vessel. Three PSOs shall be stationed aboard the survey vessel *Geo Arctic* to monitor the exclusion zones centered on the airguns and to request mitigation actions when necessary.

(iv) At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the PSO(s) on-watch. If a marine mammal is within or closely approaching its designated exclusion zone, the seismic acoustic sources must be immediately powered down or shutdown (in accordance with condition 6(d) above).

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

(vi) PSO(s) shall watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge. The observer(s) shall scan systematically with the unaided eye and 7 × 50 reticle binoculars, supplemented during good visibility conditions with 20 × 60 image-stabilized Zeiss Binoculars or Fujinon 25 × 150 ''Big-eye'' binoculars, a thermal imaging (FLIR) camera, and night-vision equipment when needed.

(vii) When marine mammal is sighted, information to be recorded by PSOs shall include the following information:

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

(B) additional details for any unidentified marine mammal or unknown observed;

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

(D) the positions of other vessel(s) in the vicinity of the observer location.

(viii) The ship's position, speed of the vessel, water depth, sea state, ice cover, visibility, airgun status (ramp up, mitigation gun, or full array), and sun glare shall be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

(ix) ION shall work with its observers to develop a means for recording data that does not reduce observation time significantly.

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

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

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

(b) At Night and Poor Visibility Visual Monitoring

(i) Night-vision equipment (Generation 3 binocular image intensifiers, or equivalent units) shall be available for use at night and poor visibility if visual monitoring is conducted.

(ii) A forward looking thermal imaging (FLIR) camera system mounted on a high point near the bow of the icebreaker shall also be available to assist with detecting the presence of seals and polar bears on ice and in the water ahead of the airgun array.

(iii) FLIR and NVD Monitoring Protocols

- All PSOs shall monitor for marine mammals according to the procedures outlined in the Marine Mammal Observer handbook.
- One PSO will be responsible for monitoring the FLIR system (IR–PSO) during most darkness and twilight periods. The on-duty IR–PSO shall monitor the IR display and alternate between the two search methods described below. If a second PSO is on watch, they shall scan the same area as the FLIR using the NVDs for comparison. The two PSOs shall coordinate what area is currently being scanned.
- The IR–PSO should rotate between the search methods (see below) every 30 minutes in the following routine:
  - 00:00–00:30: Method I
  - 00:30–01:00: Method II, Port side
  - 01:00–01:30: Method I
  - 01:30–02:00: Method II, Starboard side

(iv) FLIR and NVD Search Methods

(A) Method I: Set the horizontal tilt of the camera to an angle that provides an adequate view out in front of the vessel and also provides good resolution to potential targets. Pan back and forth across the forward 180° of the vessels heading at a slow-scanning rate of approximately 1–2°/sec, as one would with binoculars.

(B) Method II: Set the horizontal tilt of the camera to an angle that provides an adequate view out in front of the vessel, and then set the camera at a fixed position that creates a swath of view off the bow and to one side of the vessel.

(c) Field Data-Recording, Verification, Handling, and Security

(i) PSOs shall record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data shall be entered into a laptop computer running a custom computer database.

(ii) The accuracy of the data entry shall be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts.

(iii) Quality control of the data shall be facilitated by

(A) The start-of-season training session,

(B) Subsequent supervision by the onboard field crew leader, and

(C) Ongoing data checks during the field season.

(iv) Data shall be backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel.

(v) Observation effort data shall be designed to capture the amount of PSO effort itself, environmental conditions that impact an observer's ability to detect marine mammals, and the equipment and method of monitoring being employed. These data shall be collected every 30 minutes or when an effort variable changes (*e.g.,* change in the equipment or method being used to monitor, on/off-signing PSO, etc.), and shall be linked to sightings data.

(vi) Effort and sightings data forms shall also include fields to capture information specific to monitoring in darkness and to more accurately describe the observation conditions. These fields include the following:

(A) Observation Method: FLIR, NVD, spotlight, eye (naked eye or regular binoculars), or multiple methods. This data is collected every 30 minutes with the Observer Effort form and with every sighting.

(B) Cloud Cover: Percentage. This can impact lighting conditions and reflectivity.

(C) Precipitation Type: Fog, rain, snow, or none.

(D) Precipitation Reduced Visibility: Confirms whether or not visibility is reduced due to precipitation. This will be compared to the visibility distance (# km) to determine when visibility is reduced due to lighting conditions versus precipitation.

(E) Daylight Amount: Daylight, twilight, dark. The addition of the twilight field has been included to record observation periods where the sun has set and observation distances may be reduced due to lack of light.

(F) Light Intensity: Recorded in footcandles (fc) using an incident light meter. This procedure was added to quantify the available light during twilight and darkness periods and may allow for light-intensity bins to be used during analysis.

(d) Acoustic Monitoring

(i) Sound Source Verification

(A) ION shall use measurements of the same airgun source taken in the Canadian Beaufort Sea in 2010, along with sound velocity measurements taken in the Alaskan Beaufort Sea at the start of the 2012 survey to update the propagation model and estimate new exclusion zones.

(B) Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 μPa (rms) for the airgun array(s). The configurations of airgun arrays shall include at least the full array and the operation of a single source that will be used during power downs.

(C) The test results shall be reported to NMFS within 5 days of completing the test.

(ii) Seismic Hydrophone Streamer Recordings of Vessel Sounds: ION shall use the hydrophones in the seismic streamer to monitor the icebreaker noise.

(A) Once every hour the airguns would not be fired at 2 consecutive intervals and instead a period of background sounds would be recorded, including the sounds generated by the vessels.

(B) In order to estimate sound energy over a larger range of frequencies, results from previous measurements of icebreakers could be generalized and added to the data collected during this project.

(iii) Over-Winter Acoustic Recorders

(A) ION shall collaborate with other industry operators to deploy acoustics recorders in the Alaskan Beaufort Sea in fall of 2012, to be retrieved during the 2013 open-water season.

(B) Acoustic data from the over-winter recorders shall be analyzed to address the following objectives:

- Characterize the sounds and propagation distances produced by Ion's source vessel, icebreaker, and airguns on and to the edge of the U.S. Beaufort Sea shelf,
- Characterize ambient sounds and marine mammal calls during October and November to assess the relative effect of ION's seismic survey on the background conditions, and to characterize marine mammal calling behavior, and
- Characterize ambient sound and enumerate marine mammal calls through acoustic sampling of the environment form December 2012 through July 2013, when little or no anthropogenic sounds are expected.

8. Reporting:

(a) Sound Source Verification Report: A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190-, 180-, 160-, and 120-dB re 1 μPa (rms) radii of the airgun arrays will be submitted within 120 hr after collection and analysis of those measurements at the start of the field season. This report shall specify the distances of the exclusion zones that were adopted for the marine survey activities.

(b) Field Reports: Throughout the survey program, the observers shall prepare a report each day or at such other interval as the IHA (if issued), or ION may require summarizing the recent results of the monitoring program. The field reports shall summarize the species and numbers of marine mammals sighted. These reports shall be provided to NMFS and to the survey operators.

Technical Reports

(c) Technical Report: The Results of the vessel-based monitoring, including estimates of ''take by harassment'', shall be presented in the 90-day and final technical reports. Reporting will address the requirements established by NMFS in the IHA (if issued). The technical report will include:

(i) Summaries of monitoring effort: Total hours, total distances, and distribution of marine mammals through the study period accounting for sea state and other factors affecting visibility and detectability of marine mammals;

(ii) Methods, results, and interpretation pertaining to all acoustic characterization work and vessel-based monitoring;

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

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

(v) Analyses of the effects of survey operations:

- Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
- 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''.

(vi) To better assess impacts to marine mammals, data analysis should be separated into periods when a seismic airgun array (or a single airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot: (A) Data for periods when a seismic array is active and when it is not; and (B) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(vii) Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as: (A) Initial sighting distances versus airgun activity state; (B) closest point of approach versus airgun activity state; (C) observed behaviors and types of movements versus airgun activity state; (D) numbers of sightings/individuals seen versus airgun activity state; (E) distribution around the survey vessel versus airgun activity state; and (F) estimates of take by harassment.

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

(ix) 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.

(x) The report should clearly compare authorized takes to the level of actual estimated takes.

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

9. Notification of Injured or Dead Marine Mammals

(a) In the unanticipated event that survey operations clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (*e.g.,* ship-strike, gear interaction, and/or entanglement), ION shall immediately cease survey operations and immediately report the incident to the Supervisor of Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Shane.Guan@noaa.gov* and the Alaska Regional Stranding Coordinators (*Aleria.Jensen@noaa.gov* and *Barbara.Mahoney@noaa.go*v). The report must include the following information:

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

(ii) The name and type of vessel involved;

(iii) The vessel's speed during and leading up to the incident;

(iv) Description of the incident;

(v) Status of all sound source use in the 24 hours preceding the incident;

(vi) Water depth;

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

(viii) Description of marine mammal observations in the 24 hours preceding the incident;

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

(x) The fate of the animal(s); and

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

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

(b) In the event that ION discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.,* in less than a moderate state of decomposition as described in the next paragraph), ION will immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Shane.Guan@noaa.gov* and the NMFS Alaska Stranding Hotline (1–877–925–7773) and/or by email to the Alaska Regional Stranding Coordinators (*Aleria.Jensen@noaa.gov* and *Barabara.Mahoney@noaa.gov*). The report must include the same information identified in Condition 10(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with ION to determine whether modifications in the activities are appropriate.

(c). In the event that ION discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ION shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Shane.Guan@noaa.gov* and the NMFS Alaska Stranding Hotline (1–877–925–7773) and/or by email to the Alaska Regional Stranding Coordinators (*Aleria.Jensen@noaa.gov* and *Barbara.Mahoney@noaa.gov*), within 24 hours of the discovery. ION shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. ION can continue its operations under such a case.

10. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

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

12. A copy of this Authorization and the Incidental Take Statement must be in the possession of each seismic vessel operator taking marine mammals under the authority of this Incidental Harassment Authorization.

13. ION is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion.

Endangered Species Act (ESA)

The bowhead whale is the only marine mammal species currently listed as endangered under the ESA that could occur during ION's proposed in-ice seismic survey period. The Beringia DPS of the Alaska stock of bearded seals and the Arctic stock of ringed seals are proposed for listing as threatened under the ESA. Final decisions concerning the listing of these species are pending.

NMFS' Permits and Conservation Division has initiated consultation with NMFS' Protected Resources Division under section 7 of the ESA on the issuance of an IHA to ION under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of an IHA.

National Environmental Policy Act (NEPA)

NMFS is currently preparing an Environmental Assessment, pursuant to NEPA, to determine whether or not this proposed activity may have a significant effect on the human environment. This analysis will be completed prior to the issuance or denial of the IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to authorize the take of marine mammals incidental to ION's 2012 in-ice seismic survey in the Beaufort and Chukchi Seas, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: August 13, 2012.

Helen M. Golde,

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

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