# Application for the Incidental Harassment Authorization for the Taking of Whales and Seals in Conjunction with the SAE Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, Summer 2013

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# 1.0 DETAILED DESCRIPTION OF SPECIFIC ACTIVITIES EXPECTED TO RESULT IN THE INCIDENTAL TAKING OF MARINE MAMMALS

SAExploration, Inc. (SAE), in partnership with Kuukpik Corporation (Kuukpik), plans to conduct three-dimensional (3D) nodal or ocean-bottom cable (OBC) seismic surveys in state and federal waters in the Beaufort Sea during the open water season of 2013. Because this operation could acoustically harass local marine mammals, a form of take as defined under the Marine Mammal Protection Act (MMPA), it is subject to governance under MMPA. Incidental and unintentional harassment takes are permitted with the issuance of an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS). MMPA identifies 14 specific items that must be addressed when applying for an IHA, which allow NMFS to fully evaluate whether the proposed actions remain incidental and unintentional. The 14 items are addressed below relative to the 2013 offshore component of this seismic survey program.

## 1.1 Overview of Activity

The planned 3D seismic survey would occur in the nearshore waters of the Colville River Delta. The exact location of the receiver area is shown in Figure 1-1, and represents a total area of 1,225 square kilometers (473 square miles).

The components of the project include laying nodal recording sensors (nodes) on the ocean floor, operating seismic source vessels towing active airgun arrays, and retrieval of nodes. There will also be additional boat activity associated with crew transfer, recording support, and additional monitoring for marine mammals.

The phases of the operation and specifications of the equipment to be used are addressed individually below.

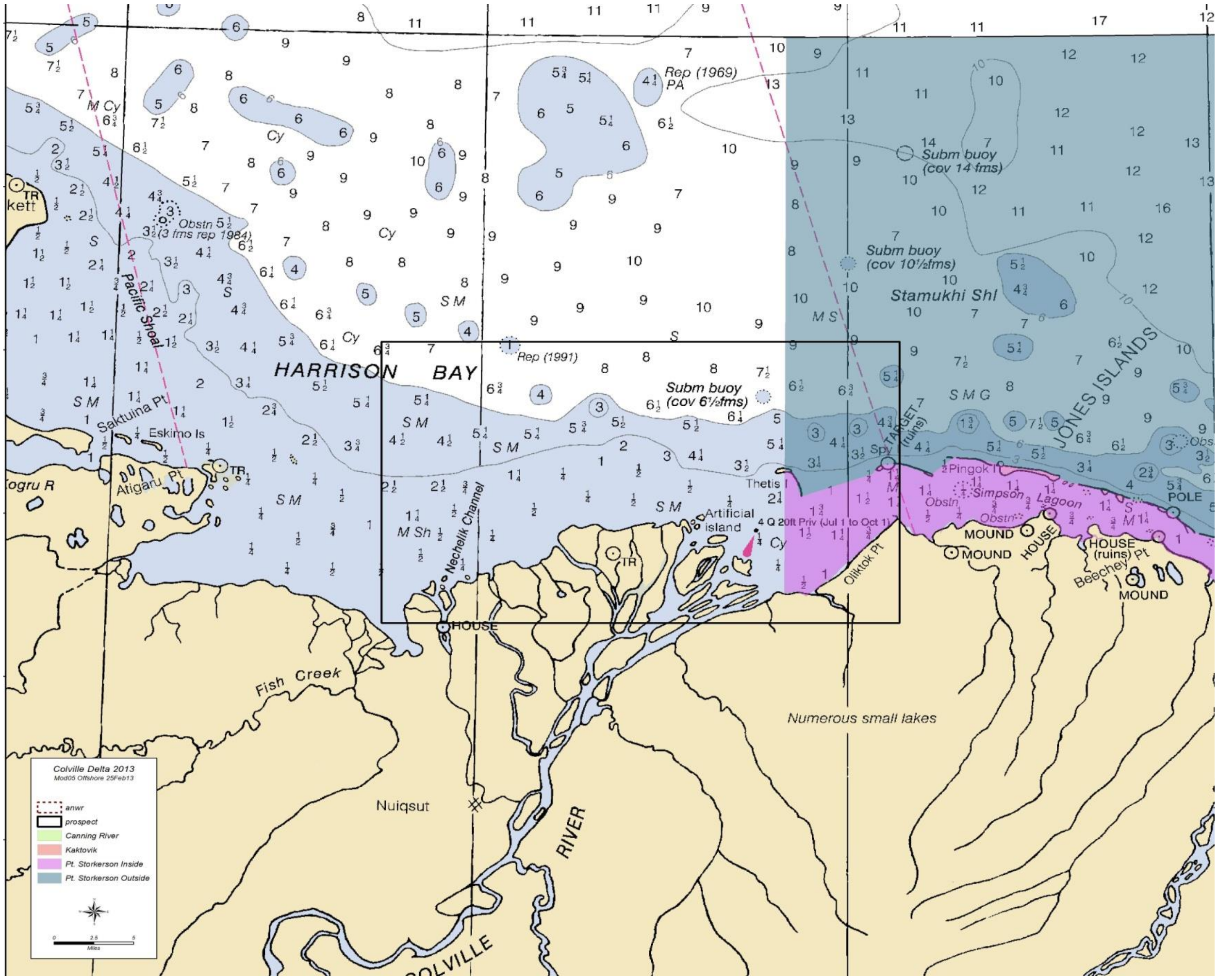


**Figure 1-1. Proposed Seismic Survey Area**

## 1.2 Project Details

### Survey Design

The seismic survey layout is found in Figure 1-2. Two-hundred-ten nodal (receiver) lines will be laid perpendicular from the shoreline spaced 200 to 268 meters (660 to 880 feet) apart. Receiver line lengths range between 20 and 32 kilometers (13 and 20 miles) long. The total receiver area is 1,225 square kilometers (473 square miles). Sixty-five source (shot) transect lines will run perpendicular to the receiver nodal lines, each spaced 300 to 335 meters (990 to 1,100 feet) apart. These lines will be approximately 51 kilometers (32 miles) long. The total source survey area is 995 square kilometers (384 square miles).

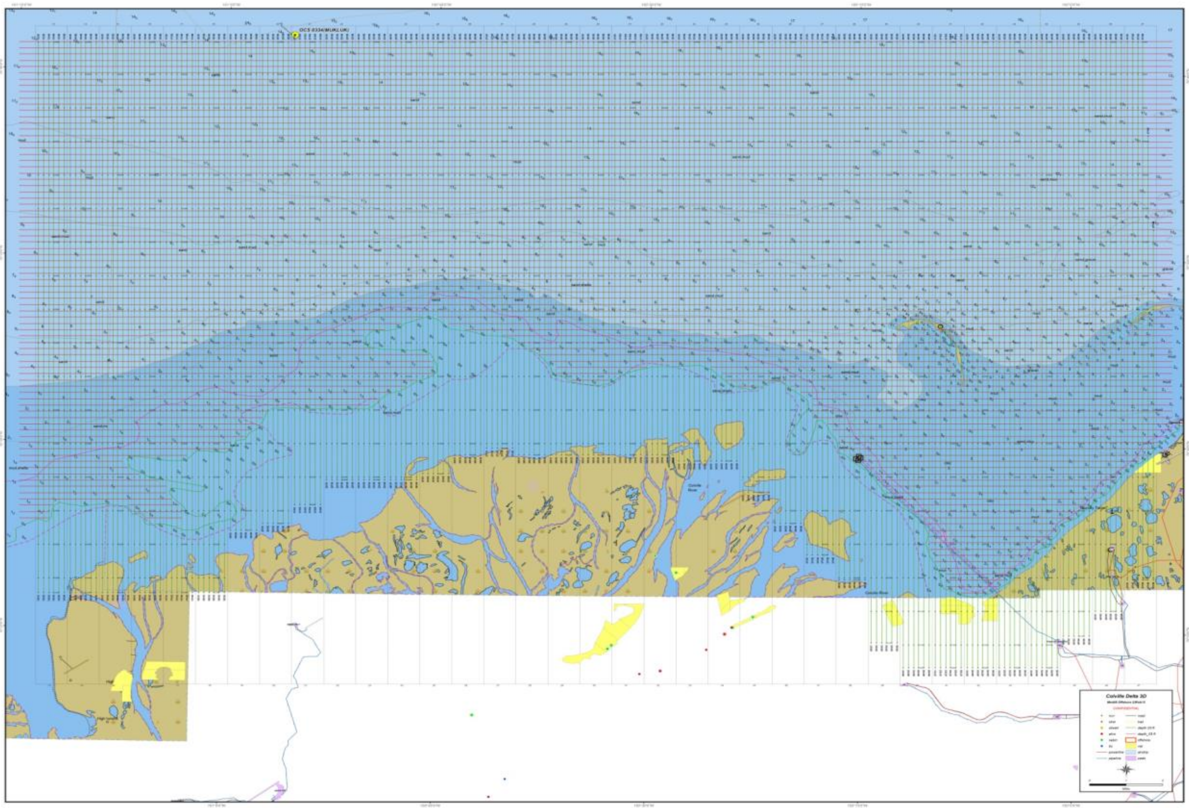

**Figure 1-2. Configuration of Shot and Receiver Lines**

The receiver layout and seismic survey data will be acquired using the stroke technique--multiple strokes with 6 receiver lines per stroke. Source lines will be acquired perpendicular to the receiver lines for each stroke, only 6 receiver lines will be laid at a time, with enough associated source survey to fully acquisition data for that stroke. Once data is acquired for a given stroke, the nodal lines (strings of individual nodes tethered together by rope) will be retrieved and repositioned into a second 6 line stroke, and the seismic survey operations begin anew. This will allow the most rapid acquisition of data using the minimum number of active nodes.

## Acoustical Sources

The acoustic sources of primary concern are the airguns that will be deployed from the seismic source vessels. However, there are other noise sources to be addressed including the pingers and transponders associated with locating receiver nodes, as well as propeller noise from the vessel fleet.

### *Seismic Source Array*

The seismic sources to be used will include using 880 and 1,760 cubic inch sleeve airgun arrays for use in the deeper waters, and a 440 cubic inch array in the very shallow (<1.5 meter deep) water locations. Each of the arrays will be arrayed in a configuration outlined in Appendix A. The arrays will be towed approximately 15 to 22 meters (50 to 75 feet) behind the source vessel stern, at a depth of 4 meters (12 feet), and towed along predetermined source lines at speeds between 4 and 5 knots. Two vessels with full arrays will be operating simultaneously in an alternating shot mode; one vessel shooting while the other is recharging. Shot intervals are expected to be about 8 to 10 seconds for each array resulting in an overall shot interval of 4 to 5 seconds considering the two arrays. Operations are expected to occur 24 hours a day.

Based on the manufacturer's specifications, the 440 cubic inch array has a peak-peak estimated 1-meter sound source of 239.1 dB re 1 µPa (9.0 bar-m; Far-field Signature, Appendix A), and root mean square (rms) at 221.1 dB re 1 µPa. The 880 cubic inch array produces sound levels at source estimated at peak-peak 244.86 dB re 1 µPa @ 1 m (17.5 bar-m; Far-field Signature, Appendix A), and rms at 226.86 dB re 1 µPa. The 1,760 cubic inch array has a peak-peak estimated sound source of 254.55 dB re 1 µPa @ 1 m (53.5 bar-m; Far-field Signature, Appendix A), with an rms sound source of 236.55 dB re 1 µPa. The 1,760 cubic inch array has a sound source level approximately 10 dB higher than the 880 cubic inch array.

The source directivity plots for the three airgun arrays are shown in Appendix A. They clearly indicate that the acoustical broadband energy is concentrated along the vertical axis (focused downward), while there is little energy focused horizontally. The spacing between airguns results in offset arrival timing of the sound energy. These delays "smear" the sound signature as offset energy waves partially cancel each other, which reduces the amplitude in the horizontal direction. Thus, marine mammals near the surface and horizontal to the airgun arrays would receive sound levels considerably less than a marine mammal situated directly beneath the array, and at levels probably less than predicted by the acoustical spreading model. As a result, the estimates of the distances to NMFS Level A and B take criterion determined for this IHA request should be considered conservative.

### *Pingers and Transponders*

An acoustical pinger system will be used to position and interpolate the location of the nodes. Pingers will be positioned at predetermined intervals throughout the shoot patch and signals transmitted by the pingers will be received by a transponder mounted on a recording and retrieving vessel. The pingers and transponder communicate via sonar and, therefore, each generates underwater sounds potentially disturbing to marine mammals. The exact model of pinger system to be used is yet to be determined, but available pingers transmit short pulses at between 19 to 55 kHz and have published source levels between 185 and 193 dB re 1 µPa @ 1 m (rms). Available transponders generally transmit at between 7 and 50 kHz, with similar source levels also between 185 and 193 dB re 1 µPa @ 1 m. Aerts et al. (2008) measured the sound source signature of the same pingers and transponders to be used in this survey and found the pinger to have a source level of 185 dB re 1 µPa and the transponder at 193 dB re 1 µPa.

Both the pingers and the transponders produce noise levels within the most sensitive hearing range of seals (10 to 30 kHz; Schusterman 1981) and beluga whales (12 to ~100 kHz; Wartzok and Ketten 1999), and the functional hearing range of baleen whales (20 Hz to 30 kHz; NRC 2003), although baleen whale hearing is probably most sensitive nearer 1 kilohertz (Richardson et al. 1995). However, given the low acoustical output, the range of acoustical harassment to marine mammals is between about 24 to 61 meters (80 and 200 feet), or significantly less than the output from the airgun arrays, and is not loud enough to reach injury levels in marine mammals beyond 6 meters (20 feet). Marine mammals are likely to respond to pinger and transponder transmission similar to airgun pulses, but only when very close (a few feet) to the sources.

### *Vessels*

Several offshore vessels will be required to support recording, shooting, and housing in the marine and transition zone environments. The exact vessels that will be used have not yet been determined. However, the types of vessels that will be used to fulfill these roles are found in Table 1-1.

**Table 1-1 – Seismic Program Vessels**

| Vessel | Operation | Size (feet) | Gross Tonnage | No. of Berths | Main Activity/Frequency | Source Levels* (dB) |
|---|---|---|---|---|---|---|
| **TBD** | Source Vessel | 120 x 25 | 100-250 | 10-20 | Seismic data acquisition 24 hour operation | 179.0 |
| **TBD** | Source Vessel | 80 x 25 | 100-250 | 10-20 | Seismic data acquisition 24 hour operation | 165.7 |
| **TBD** | Node equipment deployment and retrieval | 80 x 20 | 50 | 16 | Deploying and retrieving nodes 24 hour operation | 165.3 |
| **TBD** | Node equipment deployment and retrieval | 80 x 20 | 50 | 16 | Deploying and retrieving nodes 24 hour operation | 165.3 |
| **TBD** | Mitigation/Housing Vessel | 90 x 20 | 100 | 20-30 | House crew 24 hour operation | 200.1 |
| **TBD** | Crew Transport Vessel | 30 x 20 | 20-30 | 3 | Transport crew intermittent 8 hours | 191.8 |
| **TBD** | Bow Picker | 30 x 20 | 20-30 | 3 | Deploying and retrieving nodes Intermittent operation | 171.8 |
| **TBD** | Bow Picker | 30 x 20 | 20-30 | 3 | Deploying and retrieving nodes Intermittent operation | 171.8 |

**Sound source levels from Aerts et al. (2008) based on empirical measurements of the same vessels expected to be used during this survey.*

***Source Vessels*** - Source vessels will have the ability to deploy two arrays off the stern using large A-frames and winches and have a draft shallow enough to operate in waters less than 1.5 meters (5 feet) deep. On the source vessels the airgun arrays are typically mounted on the stern deck with an umbilical that allow the arrays to be deployed and towed from the stern without having to re-rig or move arrays. A large bow deck will allow for sufficient space for source compressors and additional airgun equipment to be stored. The two marine vessels likely to be used are the *Peregrine* and *Miss Diane*. Both were acoustically measured by Aerts et al. (2008). The *Peregrine* was found to have a source level of 179.0 dB re 1 µPa, while the smaller *Miss Diane* has a source level of 165.7 dB re 1 µPa.

***Recording Deployment and Retrieval*** - Jet driven shallow draft vessels and bow pickers will be used for the deployment and retrieval of the offshore recording equipment. These vessels will be rigged with hydraulically driven deployment and retrieval squirters allowing for automated deployment and retrieval from the bow or stern of the vessel. These vessels will also carry the recording equipment on the deck in fish totes. Aerts et al. (2008) found the recording and deployment vessels to have a source level of approximately 165.3 dB re 1 µPa, while the smaller bow pickers produce more cavitation resulting in source levels of 171.8 dB re 1 µPa.

***Housing and Transfer Vessels*** - Housing vessel(s) will be larger with sufficient berthing to house crews and management. The housing vessel will have ample office and bridge space to facilitate the role as the mother ship and central operations. Crew transfer vessels will be sufficiently large to safely transfer crew between vessels as needed. Aerts et al. (2008) found the housing vessel to produce the loudest propeller noise of all the vessels in the fleet (200.1 dB re 1 µPa), but this vessel is mostly anchored up once it gets on site. The crew transfer vessel also travels only infrequently relative to other vessels, and is usually operated at different speeds. During higher speed runs shore the vessel produces source noise levels of about 191.8 dB re 1 µPa, while during slower on-site movements the vessel source levels are only 166.4 dB re 1 µPa (Aerts et al. 2008).

***Mitigation Vessel*** - To facilitate marine mammal monitoring of the Level B harassment zone, one dedicated vessel will be deployed a few kilometers northeast of the active seismic source vessels to provide a survey platform for 2 or 3 Protected Species Observers (PSOs). These PSOs will work with concert with PSOs stationed aboard the source vessels, and will provide an early warning of the approach of any bowhead whale, beluga, or other marine mammal. It is assumed that the vessel will be of similar size and acoustical signature as a bowpicker.

## 1.3 Maintaining Safe Radii

The seismic airguns that will be used during SAE's Beaufort operation have the potential to acoustically injure marine mammals at close proximity. These Level A takes are not authorized by IHAs and measures must be taken to avoid them. The NMFS criteria for Level A take are 180 dB for whales and 190 dB for seals (all rms). To avoid exposing marine mammals to these received noise levels, safety zones will be established based on the ZOIs for the 440 (221.1 dB source), 880 (226.86 dB source) and 1,760 (236.55 dB source) cubic inch airgun arrays. Based on the transmission losses empirically measured for these arrays by Aerts et al. (2008) elsewhere (BP Liberty) in the Beaufort Sea, the distances to the 190 and 180 dB isopleths (safety zone radii) are found in Table 1-2. Qualified PSOs will be deployed aboard the seismic vessels to monitor the safety zones (See Appendix B, Marine Mammal Monitoring and Mitigation Plan), and alert operations to shut down at the approach of a marine mammal to these safety zones.

**Table 1-2. Safety zone radii for pinnipeds (190 dB) and cetaceans (180 dB) for each airgun array.**

| Array (cubic inch) | Source Level (dB) | 190 dB radius (m) | 180 dB radius (m) |
|---|---|---|---|
| 440 | 221.10 | 126 | 325 |
| 880 | 226.86 | 167 | 494 |
| 1,760 | 236.55 | 321 | 842 |

While the pingers and transponders that will be used to relocate nodes generate source sound levels (185 to 193 dB) that exceed Level A criteria, the associated ZOIs are so small (radii of 0 to 6 meters) that marine mammal monitoring is impractical. Operators will, however, ensure that no marine mammals are in the immediate vicinity before deploying pingers and transponders. Both the housing and crew transfer vessel can produce noise exceeding 190 or 180 dB re 1 µPa when traveling at higher speeds, but the safety zone radii only extend from 2 to 4 meters from the vessel, a distance impractical to monitor.

## 2.0 DATES AND DURATION OF PROPOSED ACTIVITY AND SPECIFIC GEOGRAPHICAL REGION

The request for incidental harassment authorization is for the 2013 open water season (July 1 to October 15). All associated activities, including mobilization, survey activities, and demobilization of survey and support crews, would occur inclusive of the above dates. The actual data acquisition is expected to take approximately 70 days (July 25 to September 30), dependent of weather. Based on past similar seismic shoots in the Beaufort Sea, it is expected that effective shooting would occur over about 70 percent of the 70 days (or about 1,176 hours). If required in the Conflict Avoidance Agreement (CAA), surveys will temporarily cease during the fall bowhead whale hunt to avoid acoustical interference with the Cross Island, Kaktovik, or Barrow based hunts. Still, seismic surveys will begin in the more offshore areas first with the intention of completing survey of the bowhead whale migration corridor (waters >15 meters deep) region prior to the arrival of the fall migration. It is expected that by September 1, the northernmost 8 to 10 kilometers of the survey box will have been shot, with the remaining area to be surveyed is found 5 to 8 kilometers south of the southern edge of the bowhead migration corridor (the 15-meter isobath). About 12 percent of the survey box falls within the bowhead migration corridor.

## 3.0 THE SPECIES AND NUMBERS OF MARINE MAMMALS LIKELY TO BE FOUND WITHIN THE ACTIVITY AREA

The species of marine mammals that are most likely to be found in the activity area, at least seasonally, are the bowhead whale, gray whale, beluga whale, ringed seal, spotted seal, and bearded seal. Gray whales are included in this list because they have been found penetrating deeper into the Beaufort Sea in recent years (Green and Negri 2005, Green et al. 2007). Finding summering gray whales in the project area would no longer be considered surprising.

A humpback whale cow/calf pair was observed in Smith Bay, 120 kilometers (75 miles) west of the activity area (Hashagen et al. 2009), but this is considered an extralimital sighting. Other Alaskan marine mammals that might also occur extralimitally in the Beaufort Sea including the minke whale, fin whale, North Pacific right whale, harbor porpoise, killer whale, ribbon seal, and narwhal. Killer whales have been observed off Point Barrow in recent years (G. Green, pers. obs.), but there are no recent records near the project area. Pacific walrus do occasionally wander into the Beaufort Sea (one was observed offshore Prudhoe Bay in November 2002 [Green et al. 2003]), and polar bears are a regular inhabitant of the activity area vicinity; however, these species (plus the sea otter) are managed by the U.S. Fish and Wildlife Service (USFWS) and, thus, are not addressed further in this document.

The world population and local numbers of the six species most likely to be found in the vicinity of the activity area are found in Table 3-1. Summering bowhead, gray, and beluga whales would be considered rare in the vicinity of the activity area. Small numbers of summering bowhead and gray whales have been recorded in Smith Bay and near Point Barrow (Green and Negri 2005, Green et al. 2007), and the occasionally wandering bowhead whale could be encountered nearly anywhere in the Beaufort Sea (Moore et al. 2010). Beluga whales generally summer within the northern pack ice, but have been observed in small numbers along the Beaufort coast during the summer months. None of these species are expected to be encountered during the July and August activity periods. The likelihood of observing beluga whales, as well as bowhead whales, in the activity area increases with the southern advance of the pack ice during the fall. Both bowhead and beluga whales migrate through the Alaskan Beaufort Sea from late August to early October, with the peak in September. Only 12 percent of the seismic survey box extends north of the 15-meter (50-foot) depth contour, the recognized southern boundary of the primary bowhead migration corridor within the Alaskan Beaufort Sea. The seismic activities will avoid the peak of the beluga and bowhead fall migration either by shutting down during the fall bowhead whale hunt or by completing the northernmost source lines first. It is expected that by September 1, the northern 8 to 10 kilometers of the survey box will have been completed.

**Table 3-1 Marine Mammals in the Alaskan Beaufort Sea**

| Species | Abundance | Comment |
|---|---|---|
| Bowhead Whale (*Balaena mysticetus*) | 10,545 | ESA-listed as Endangered |
| Gray Whale (*Eschrichtius robutus*) | 19,126 | Rare in Beaufort Sea |
| Beluga Whale (*Delphinapterus leucas*) | 39,258 | Beaufort Sea Stock |
| Ringed Seal (*Phoca hispida*) | 249,000 | Proposed ESA listing |
| Spotted Seal (*Phoca largha*) | 101,568 | Proposed ESA listing |
| Bearded Seal (*Erignathus barbatus*) | 155,000 | Proposed ESA listing |

Source: Boveng et al. (2009), Cameron et al. (2010), Allen and Angliss (2012)

# 4.0 A DESCRIPTION OF THE STATUS, DISTRIBUTION, AND SEASONAL DISTRIBUTION (WHEN APPLICABLE) OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS LIKELY TO BE AFFECTED BY SUCH ACTIVITIES

## 4.1 Bowhead Whale (*Balaena mysticetus*)

The Western Artic stock of bowhead whale is one of five stocks recognized by the International Whaling Commission (IWC), and is currently the largest with an estimated population of 9,472 animals (Allen and Angliss 2012). This stock is currently listed as endangered under the Endangered Species Act (ESA) and "depleted" under the MMPA, although it has experienced significant growth in the past 30 years despite subsistence harvest.

This stock summers in the Canadian Beaufort Sea, migrate through the Alaskan Beaufort Sea, Chukchi Sea, and Bering Strait in the fall, and winter in the Bering Sea (Braham et al. 1984, Moore and Reeves 1993). The whales passing through the Chukchi often fall a route along the Siberian coast (Quakenbush 2007, Quakenbush et al. 2010). The whales follow open leads in the sea ice during their spring migration (March to mid-June) back to Canada (Braham et al. 1984, Moore and Reeves 1993). However, individual bowhead whales can be found throughout their range at almost any time of the year (Rugh et al. 2003, Moore et al. 2010), and they have been found summering near Pt. Barrow and Smith Bay (Green and Negri 2005, Green et al. 2007). Mocklin et al. (2012) have reported on bowheads feeding near Pt. Barrow.

Pre-whaling population estimates for bowhead whales range between 10,400 and 23,000 animals. This population was reduced to approximately 3,000 whales by commercial whaling (Woodby and Botkin 1993). Since 1978 the bowhead whale populations has been growing at an annual rate of approximately 3.2 to 3.4 percent (George et al. 2004). Most recent estimates (2004) indicated a population of about 11,800 animals (Koski et al. 2008) although NMFS's most recent estimate is 10,545 animals (Allen and Angliss 2012).

Bowhead whales are hunted in the Alaskan Beaufort Sea by whalers from the villages of Kaktovik, Nuiqsut, and Barrow. The Nuiqsut hunters base from Cross Island, 80 kilometers (50 miles) east of the Colville River Delta and 27 kilometers (17 miles) northeast of Prudhoe Bay. Fall migrating whales typically reach Cross Island in September and October (Brower 1996), although some whales might arrive as early as late August. Most bowheads fall migrate through the Alaskan Beaufort in water depths between 15 and 200 meters (50 and 656 feet) deep (Miller et al. 2002), with annual variability depending on ice conditions (whales traveling farther offshore during heavy ice cover years). Hauser et al. (2008) conducted surveys for bowhead whales near the Colville River Delta during August and September 2008, and found most bowheads between 25 and 30 kilometers (15.5 and 18.6 miles) north of the barrier islands (Jones Islands), with the nearest in 18 meters (60 feet) of water about 25 kilometers (16 miles) north of the Colville River Delta. No bowheads were observed inside the 18-meter (60-foot) isobath.

Approximately 12 percent of the potential seismic survey area occurs in water deeper than 15 meters (50 feet) where migrating bowhead whales could most likely be encountered. To avoid whale encounter, the farthest offshore source lines will be surveyed first, prior to the commencement of the fall migration, and seismic surveys, if required by the CAA, will be temporarily ceased during the Cross Island bowhead whale hunt. Much lower densities of bowhead whales might also be encountered in waters between 5 and 15 meters (15 and 50 feet) deep. Waters less than 4.5 meters (15 feet) deep are considered too shallow to support these whales, and in three decades of aerial survey by the Bureau of Ocean Energy Management (BOEM), no bowhead whale has been recorded in waters less than 5 meters (16 feet) deep (Clarke and Ferguson 2010).

## 4.2 Gray Whale (*Eschrichtius robustus*)

The eastern North Pacific (or California) gray whale is one of two stocks inhabiting the Pacific Ocean (the other the endangered western North Pacific [or Korean] stock found along the Asian coast). The eastern North Pacific stock breeds in the warm-water lagoons of coastal Baja California and Mexico and winters in the shelf waters of the Bering and Chukchi seas (Jones et al. 1984), completing each year an annual round-trip migration of 16,000 to 22,500 kilometers (9,900 to 14,000 miles). Not all whales complete the migration as some whales feed in the coastal waters of the Pacific Northwest (Calambokidis 2002, 2010), and possibly elsewhere along the migration route.

Prior to 1997, reports of gray whales in the Beaufort Sea were very rare. A single gray whale was killed at Cross Island in 1933 (Maher 1960), and small numbers were observed in the Canadian Beaufort Sea approximately 1,100 coastal kilometers (~700 coastal miles) east of Point Barrow in 1980 (Rugh and Fraker 1981). Only one gray whale was observed during extensive aerial surveys conducted in the Beaufort Sea between 1979 and 2009 (Clarke and Ferguson 2010). Sightings in the Beaufort Sea became more common, although still occasional, from 1998 to 2004 (Miller et al. 1999, Treacy 2000, Williams and Coltrane 2002), and then regularly observed from 2005 on (Green and Negri 2005, Green et al. 2007; Jankowski et al. 2008; Lyons et al. 2009). Green and Negri (2005) observed feeding gray whales near Elson Lagoon (immediately east of Pt. Barrow) in 2005, and Green et al. (2007) at Smith's Bay (approximately 100 kilometers east of Pt. Barrow) in 2007. Still, few gray whales have ever been reported in the Beaufort Sea as far east as Cape Halkett (approximately 160 kilometers east of Pt. Barrow). Their occurrence within potential seismic survey box is not expected.

## 4.3 Beluga Whale (*Delphinapterus leucas*)

The Beaufort Sea stock of beluga whale is one of five stocks occurring in Alaska (O'Corry-Crowe et al 1997). The most current population estimate is 39,258 animals (Allen and Angliss 2012). However, this estimate is based on aerial surveys conducted in 1992, and includes a smaller more conservative correction factor (to account for availability bias) than has been estimated for other aerial surveys of this species in Alaska (Frost and Lowry 1995, Allen and Angliss 2012). The current population trend is unknown, but subsistence harvest is probably well below the potential biological removal (Allen and Angliss 2012).

Like all Alaska stocks (except the Cook Inlet stock), the Beaufort Sea stock winters in the open leads and polynyas of the Bering Sea (Hazard 1988). In the spring they migrate through coastal leads over 2,000 kilometers (1,200 miles) to their summering grounds in the Mackenzie River delta where they molt, feed, and calve in the warmer estuarine waters (Braham et al. 1977). In late summer, these belugas move into offshore northern waters to feed (Davis and Evans 1982, Harwood et al. 1996, Richard et al. 2001). In the fall, they begin their migration back to their wintering grounds generally following an offshore route as they pass through the western Beaufort Sea (Richard et al. 2001).

Richard et al. (2001) tracked 12 satellite-tagged belugas and found them to pass relatively quickly (average 15 days) through the Alaskan Beaufort Sea during September. The westward routes ranged from coastal to over 650 kilometers (400 miles) offshore with all but one beluga passing at least 100 kilometers (60 miles) north of the Beaufort shoreline. Based on the above and results from numerous aerial and boat-based marine mammal surveys in the Beaufort Sea, some belugas take a more coastal route during their fall migration, but compared to the vanguard of population and the survey effort expended, nearshore travel appears to be relatively rare. Most belugas recorded during aerial surveys conducted in the Alaskan Beaufort Sea in the last two decades were found over 65 kilometers (40 miles) from shore (Miller et al. 1998, 1999; Funk et al. 2008; Christie et al. 2010; Clarke and Ferguson 2010; Brandon et al. 2011).

Few surveys reported belugas within 40 kilometers (25 miles) of shore where the planned seismic activities would occur. Green and Negri (2005) reported small beluga groups nearshore Cape Lonely (August 26) and in Smith Bay (September 4). Funk et al. (2008) reported a group just offshore of the barrier islands near Simpson Lagoon, while Aerts et al. (2008) reported summer sightings of three groups of eight animals inside the barrier islands near Prudhoe Bay.

Although it is possible for beluga whales to occur in the vicinity of the planned seismic activity during summer and fall periods of operation, any occurrence would be relatively rare, and most likely to occur during the late August or September migration period when seismic activities will be temporarily suspended to avoid any conflict with the annual fall bowhead whale hunt.

## 4.4 Ringed Seal (*Phoca hispida*)

Ringed seals are the most common marine mammal in the Beaufort, Chukchi, and Bering seas. This Alaskan stock, a subpopulation of the Arctic subspecies (*P. h. hispida*), was most recently estimated 249,000 animals (Allen and Angliss 2012), although historic estimates have ranged as high as 3.6 million (Frost et al. 1988). Some taxonomists have placed this seal in the genus *Pusa* following Rice (1998), but that usage is not universal. Ringed seals were recently (2012) listed under the Endangered Species Act (ESA) due to diminishing snow and ice from climate change. They survive the winter by digging multiple haul-out shelters and nursery lairs beneath the snow (Kelly 1988). A loss of snow cover, and ice coverage in general, poses a risk to long-term survival (Kelly et al. 2010). The final determination of the proposed listing action will be made later in 2012.

During the open-water season, ringed seals are widely dispersed as single animals or in small groups and they are known to move into coastal areas (Smith 1987, Harwood and Stirling 1992, Moulton and Lawson 2002, Green et al. 2007). During the open-water period ringed seals shift from feeding on Arctic cod associated with sea ice to Saffron cod, shrimp, euphausiids, and amphipods. They were commonly recorded during previous surveys in the vicinity of the seismic survey area (Hauser et al. 2008, Brandon et al. 2011, Green et al. 2007), and are expected to be present during all months of survey.

Ringed seals are harvested by coastal Alaska Natives and are a primary prey of polar bears and arctic foxes at some times of year.

## 4.5 Spotted Seal (*Phoca largha*)

The spotted seal is found from the Beaufort Sea to the Sea of Japan and is most numerous in the Bering and Chukchi seas (Quakenbush 1988) although small numbers do range into the Beaufort Sea during summer (Rugh et al. 1997, Lowry et al. 1998, Green et al. 2007). The Bering Sea wintering population has been estimated at 200,000 to 250,000 (Bigg 1981), with a more recent estimate of 101,568 based on aerial and icebreaker-based surveys along the ice edge in 2007 and 2008 (Boveng et al. 2009). The latter estimate is currently the best available, although it is provisional (Boveng et al. 2009). A status review of the species was completed in 2009 (Boveng et al. 2009) after the spotted seal was petitioned for listing under ESA relative to climate change and its effects on sea ice. The review found the listing as not warranted.

Pupping occurs along the Bering Sea ice front during March and April, followed by mating and molting in May and June (Quakenbush 1988). During the summer they follow the retreating ice north into the Chukchi and Bering seas, and then begin hauling out on lagoon and river delta beaches during the open water period. Several thousand use Kasegaluk Lagoon in the eastern Chukchi Sea. They begin their migration back to Bering Sea wintering grounds in October (Lowry et al. 1998).

A few spotted seals summer in the Beaufort Sea where they haulout at Oarlock Island, the Piasuk River, and the Colville River Delta (Green et al. 2007). The Colville River Delta and nearby Sagavanirktok River supported as many as 400 to 600 spotted seals, but in recent times fewer than 20 seals have been seen at any one site (Johnson et al. 1999). Spotted seals were recorded during three years (2005-2007) of barging activities between Prudhoe Bay and Cape Simpson (Green and Negri 2005, 2006; Green et al. 2007). They observed between 23 and 54 seals annually, with the peak distributions found off the Colville and Piasuk rivers. Similarly, Savarese et al. (2010) surveyed the central Beaufort Sea from 2006 to 2008 and recorded 59 to 125 spotted seals annually. Summer use of the Beaufort Sea by spotted seals may be higher than haulout counts might indicate, although no haulout site surveys have been conducted in recent years.

Because the Colville River Delta haulout site occurs within the seismic survey area, spotted seals are expected to be encountered during the survey activities. Special measures will be taken to avoid disturbing hauled out ringed seals during the seismic activities.

## 4.6 Bearded Seal (*Erignathus barbatus*)

The Alaska stock of bearded seals is seasonally found in the shelf waters of the Beaufort, Chukchi, and Bering seas. They are closely associated with ice, preferring to winter in the Bering Sea and summer along the pack ice edge in Chukchi Sea, although many summer in nearshore waters of the Beaufort Sea. Preferring areas of 70 to 90 percent ice coverage, but unlike ringed seals, few bearded seals overwinter in the Chukchi and Beaufort seas (Allen and Angliss 2012). Pupping occurs on ice floes primary in May in the Bering and Chukchi seas.

Bearded seals do not have any special status, but their seasonal dependence ice makes them vulnerable to declining ice conditions due to climate change. As a consequence, they were listed under ESA in December, 2012. There is no reliable population estimate for bearded seals. Cameron et al. (2010) provided a conservative estimate for the Beringia Distinct Population Segment (the population that winters in the Bering and Chukchi seas) of 155,000, based on data collected over the last four decades.

Bearded seals have been commonly observed in the potential survey box. Aerial and vessel-based surveys associated with seismic programs, barging, and government surveys in this area between 2005 and 2010 reported several sightings (Treacy 2002a, 2002b; Moulton et al. 2003; Green and Negri 2005, 2006; Green et al. 2007; Funk et al. 2008; Hauser et al. 2008; Savarese et al. 2010; Brandon et al. 2011; Reiser et al. 2011; Clarke et al. 2011). These seals are expected to be occasionally encountered during the seismic surveys.

# 5.0 TYPE OF INCIDENTAL TAKING AUTHORIZATION BEING REQUESTED AND METHOD OF INCIDENTAL TAKING

The incidental taking authorization requested is for Level B noise harassment (noise exceeding 160 dB re 1 µPa (rms)) associated with the towed seismic airgun arrays. The actual Level B take will depend upon number of marine mammals occurring within the 160 dB Zone of Influence (ZOI) at the time of seismic activity. No Level A injury takes (noise exceeding 180 dB re 1 µPa (rms) for cetaceans and 190 dB re 1 µPa (rms) for pinnipeds) are expected with the proposed mitigation measures (see Section 1.3 and Appendix B) in place.

# 6.0 BY AGE, SEX, AND REPRODUCTIVE CONDITION (IF POSSIBLE) THE NUMBER OF MARINE MAMMALS (BY SPECIES) THAT MAY BE TAKEN

## 6.1 Basis for Estimating Numbers of Marine Mammals That Might Be "Taken by Harassment"

Exposure to impulsive sound levels greater than 160 dB re 1 µPa (rms) can elicit behavioral changes in marine mammals that might be detrimental to health and long-term survival where it disrupts normal behavioral routines, and is the Level B criteria for (impulsive) acoustical harassment under MMPA (NMFS 2005). Exposure to sound levels greater than 180 dB re 1 µPa (rms) for cetaceans and 190 dB re 1 µPa (rms) for pinnipeds can lead to acoustical injury including temporary loss in hearing sensitivity and permanent hearing damage. These values are the MMPA Level A injury criterion. IHAs do not authorize Level A take.

The estimate of the numbers of each species of marine mammals that could be "taken" by exposure to OBC seismic array noise levels is determined by multiplying the maximum seasonal density of each species by the area that will be ensonified by greater than 160 dB re 1 µPa (rms). There is no estimate of potential Level A takes, as this will be avoided through mitigation (establishment of shutdown safety zones; see Section 1.3 and Appendix B).

### Ensonified Area

The areas ensonified by MMPA criteria exposure levels was determined by assuming that the entire survey area is ensonified (given that the distance to the 160 dB isopleth during seismic survey is greater than the distance spacing between seismic source lines), plus a buffer area around the survey box corresponding to the distance to the 160 dB isopleth. The estimated distance to the 160 dB isopleth is 3 kilometers (1.86 miles ) based on a sound source of 236.55 dB re 1 µPa (rms) for the 1,760 cubic inch seismic array and a spreading model of 18 log r + 0.0047 estimated for similar Beaufort nearshore waters (BP Liberty) by Aerts et al. (2008). (Candace Nachman, NMFS, specifically requested that empirical models developed by Aerts et al. (2008) from measurements at the Liberty prospect be used in estimating the ensonified area.) Placing a 3 kilometer buffer around the 995 square kilometer (384 square mile) seismic source area expands the ensonification (or Zone of Influence [ZOI]) area to approximately 1,476 square kilometers (570 square miles), and represents the ZOI for pinnipeds. (The distance to the 160 dB isopleth when operating the 880 cubic inch airgun array is 1.5 kilometers (0.9 miles).)

**Table 6-1. Summary of Distance to NMFS Sound Level Thresholds**

| Source | Source Level | 190 dB | 180 dB | 160 dB | 120 dB |
|---|---|---|---|---|---|
| 440 cubic inch airgun array | 221.08 dB re 1 µPa (rms) | 126 m | 325 m | 1.33 km | 4.82 km |
| 880 cubic inch airgun array | 226.86 dB re 1 µPa (rms) | 167 m | 494 m | 1.5 km | 6.35 km |
| 1,760 cubic inch airgun array | 236.55 dB re 1 µPa (rms) | 321 m | 842 m | 2.99 km | 9.57 km |

Within the 1,476 square kilometer ensonified area, 10 percent (144 square kilometers) falls within the 0 to 1.5 meter depth range, 25 percent (362 square kilometers) falls within the 1.5 to 5 meter range, 54 percent (793 square kilometers) with the 5 to 15 meter range, and 12 percent (177 square kilometers) within waters greater than 15 meters deep (bowhead migration corridor).

## Marine Mammal Densities

Density estimates were derived for bowhead whales, beluga whales, ringed seals, spotted seals, and bearded seals as described below and shown in Table 6-2. There are no available Beaufort Sea density estimates for gray whales, or extralimital species such as humpback whales, killer whales, and Pacific walrus. There expected numbers are too low to consider for take authorization. The derivation of the five species presented in Table 6.2 are provided in the discussions below.

**Table 6-2. Marine Mammal Densities in the Beaufort Sea.**

| Species | Summer Average | Summer Max. | Fall Average | Fall Max. |
|---|---|---|---|---|
| Bowhead Whale | 0.0040 | 0.0160 | 0.1226 | 0.1381 |
| Beluga Whale | 0.0030 | 0.0120 | 0.0035 | 0.0140 |
| Ringed Seal | 0.3547 | 1.4188 | 0.2510 | 1.0040 |
| Spotted Seal | 0.0177 | 0.0708 | 0.0125 | 0.0502 |
| Bearded Seal | 0.0177 | 0.0708 | 0.0125 | 0.0502 |

### *Bowhead Whale*

Summer density estimates for bowhead whales are based on surveys conducted by Brandon et al. (2011) in Harrison Bay during July and August of 2010. Their estimate, corrected for observer and availability bias (Thomas et al. 2002), was 0.004 whales per square kilometer. A maximum density (0.016/square kilometers) was derived by multiplying this value by 4 to account for variability.

Fall density estimates were based on Clarke and Ferguson's (2010) summarization of the 2000-2009 Bowhead Whale Aerial Survey Program (BWASP) conducted annually by the Bureau of Ocean and Energy Management (BOEM). The center of the potential survey box occurs between 150º and 151º longitude, and the survey area occurs in waters between 1 and 20 meters deep. Based on these same locations and water depths, LAMA Ecological and OASIS Environmental (2011) applied Thomas et al.'s (2002) bias correction factors to the number of whales and transect survey effort from September (96 animals, 9,933 kilometers) and October (42 animals, 6,143 kilometers) summarized in Clarke and Ferguson (2010) and calculated a September density of 0.1381 whales/square kilometers and an October density of 0.0977 whales/square kilometers. LAMA Ecological and OASIS Environmental (2011) also derived a mean density (0.1226 whales/square kilometers) by averaging the September and October densities, and used the higher September value as the maximum density. Recognizing the validity of this approach, these same values are used in the calculations for this IHA application.

### *Beluga Whale*

The best data available for estimating summer beluga whale densities in the Alaskan Beaufort Sea is from Moore et al. (2000) based on aerial survey data collected 1982-1986. The best fall data is from Clarke et al.'s (2011) compilation of beluga records collected during the 2006-2008 BWASP surveys. Using these sighting records (summer 9; fall 7) and associated survey effort (summer 7,447 mi; fall 8,808 mi), average group size (summer 1.63, fall 2.9), and f(0) and g(0) values from Harwood et al. (1996), Shell Offshore, Inc. (2011), estimated summer and fall average density values for nearshore Beaufort Sea belugas. They multiplied these estimates by 4 to derive a maximum density. Because these estimates can be little improved upon at this time, they are used in this IHA application to estimate harassment take.

### *Ringed Seal*

Surveys for ringed seals have been recently conducted in the Beaufort Sea by Kingsley (1986), Frost et al. (2002), Moulton and Lawson (2002), Green and Negri (2005), and Green et al. (2006, 2007). The shipboard monitoring surveys by Green and Negri (2005) and Green et al. (2006, 2007) were not systematically based, but are useful in estimating the general composition of pinnipeds in the Beaufort nearshore, including the Colville River Delta. Frost et al.'s aerial surveys were conducted during ice coverage and don't fully represent the summer and fall conditions under which the Beaufort surveys will occur. Moulton and Lawson (2002) conducted summer shipboard-based surveys for pinnipeds along the nearshore Beaufort Sea coast and developed seasonal average and maximum densities representative of SAE's Beaufort summer seismic project, while the Kingsley (1986) conducted surveys along the ice margin representing fall conditions.

### *Spotted Seal*

Green and Negri (2005) and Green et al. (2006, 2007) recorded pinnipeds during barging activity between West Dock and Cape Simpson, and found high numbers of ringed seal in Harrison Bay, and peaks in spotted seal numbers off the Colville River Delta where a haulout site is located. Approximately

5% of all phocid sightings recorded by Green and Negri (2005) and Green et al. (2006, 2007) were spotted seals, which provide a suitable estimate of the proportion of ringed seals versus spotted seals in the Colville River Delta and Harrison Bay. Thus, the estimated densities of spotted seals in the seismic survey area were derived by multiplying the ringed seal densities from Moulton and Lawson (2002) and Kingsley (1986) by 0.05.

### *Bearded Seal*

Bearded seals were also recorded in Harrison Bay and the Colville River Delta by Green and Negri (2005) and Green et al. (2006, 2007), but at lower proportions to ringed seals than spotted seals. However, estimating bearded seal densities based on the proportion of bearded seals observed during the barge-based surveys results in densities estimates that appear unrealistically low given density estimates from other studies, especially given that nearby Thetis Island is used as a base for annually hunting this seal (densities are seasonally high enough for focused hunting). For conservative purposes, the bearded seal density values used in this application are derived from Stirling et al.'s (1982) observations that the proportion of eastern Beaufort Sea bearded seals is 5 percent that of ringed seals, similar as was done for spotted seals.

## 6.2 Exposure Calculations

The estimated potential harassment take of local marine mammals by the SAE's Beaufort seismic project was determined by multiplying the animal densities in Table 6-2 with the area ensonified by seismic-generated noise greater than 160 dB re 1 µPa (rms) that constitutes habitat for each respective species. For pinnipeds, which occupy all water depths, this includes the entire seismic survey area plus the additional 3 kilometer (1.86 mile) buffer of noise exceeding 160 dB, or 1,476 square kilometers (570 square miles).

Although the vast majority of bowhead whales migrate through the Beaufort sea in waters greater than 15 meters (50 feet) deep (Miller et al. 2002), feeding and migrating bowheads have been found in waters as shallow as 5 meters (16 feet) (Clarke et al. 2011). Thus, the seismic survey area potentially inhabitable by bowhead whales is all waters greater than 5 meters deep. This area, including the 3 kilometer buffer, is 970 square kilometers (375 square miles).

Beluga whales have been observed inside the barrier islands where they would have to traverse water depths as low as 1.8 meters, but these whales are unlikely to inhabit the shallowest water (<1.5 meters deep) inside the barrier islands where stranding risk can be high. For this application, the area of beluga habitat potentially ensonified (>160 dB) by the seismic operations is the waters greater than 1.5 meters (5 feet) deep with the 3 kilometer buffer, or approximately 1,332 square kilometers (514 square miles). The resulting exposure calculations are found in Table 6-3.

**Table 6-3. Number of Marine Mammals Potentially Exposed to Received Sound Levels >160 dB.**

| Species | Summer Ave. | Summer Max. | Fall Ave. | Fall Max. | Total Ave. | Total Max. |
|---|---|---|---|---|---|---|
| Bowhead Whale (>15 m) | 1 | 3 | 22 | 24 | 23 | 27 |
| Bowhead Whale (>5 m) | 4 | 16 | 119 | 134 | 123 | 150 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Beluga Whale | 4 | 16 | 5 | 19 | 9 | 35 |
| Ringed Seal | 523 | 2,094 | 370 | 1,482 | 893 | 3,576 |
| Spotted Seal | 26 | 105 | 18 | 74 | 44 | 179 |
| Bearded Seal | 26 | 105 | 18 | 74 | 44 | 179 |

Bowhead whale take estimates were calculated both for waters >5 and >15 meters deep. Because the seismic surveys are expected to be operating 5 to 8 kilometers south of the edge of the migration corridor by the time the fall migration commences, the fall exposure numbers (fall maximum of 24 whales) for waters greater than 15 meters deep do not apply, and should be subtracted from the exposure estimate for waters greater than 5 meters deep (134 minus 24) leaving an exposure estimate of 110 whales. However, even this fall maximum estimate is likely very conservative given the fall density estimate is skewed by higher whale numbers in the deeper waters.

The exposure calculations that were based on maximum densities, plus any other adjustments based on group size, were used to derive the requested take authorization also found in Table 6-4.

**Table 6-4. The Estimated and Requested Take of Marine Mammals.**

| Species | Estimated Take | Take Authorization Request |
|---|---|---|
| Bowhead Whale | 126 | 126 |
| Beluga Whale | 35 | 35 |
| Ringed Seal | 3,576 | 3,576 |
| Spotted Seal | 179 | 179 |
| Bearded Seal | 179 | 179 |
| Humpback Whale | 0 | 2 |
| Gray Whale | 0 | 2 |
| Narwhal | 0 | 2 |
| Ribbon Seal | 0 | 2 |

The take authorization request also includes requested authorization for species in which the estimated take is zero, but for which records for the Alaskan Beaufort Sea occur (i.e., humpback whale, gray whale, narwhal, and ribbon seal).

The take authorization requests also do not account for mitigation measures that will be implemented including shutting down operations during the fall bowhead hunt (thereby avoiding any noise exposure during the peak of fall bowhead whale and beluga migration) and completing the seismic survey in waters greater than 15 meters (50 feet) deep in August (thereby avoiding seismic survey within the bowhead whale migration corridor after the fall hunt). These measures, coupled with ramping up of airguns, should greatly reduce the estimated take from seismic survey operations (See Appendix B, *Marine Mammal Monitoring and Mitigation Plan*).

The estimated take as a percentage of the marine mammal stock is 1.4 percent or less in all cases (Table 6-5). The highest percent of population estimated to be taken is for the bowhead whale. However, again, this estimated take does not take into account mitigation measures such as possibly curtailing survey activities during the fall bowhead whale hunt, and completing survey of the more offshore waters in the summer. These actions alone would dramatically reduce the potential encounters of bowhead whales in the fall.

**Table 6-5. Estimated Take as Percentage of Stock.**

| Species | Abundance | Estimated Take | Percent Population |
|---|---|---|---|
| Bowhead Whale | 10,565 | 126 | 1.2% |
| Beluga Whale | 39,258 | 35 | 0.09% |
| Ringed Seal | 249,000 | 3,576 | 1.4% |
| Spotted Seal | 101,568 | 179 | 0.18% |
| Bearded Seal | 155,000 | 179 | 0.12% |
| Humpback Whale (West. North Pac.) | 938 | 0 | 0.0% |
| Gray Whale | 19,126 | 0 | 0.0% |
| Narwhal (Baffin Bay) | 45,000 | 0 | 0.0% |
| Ribbon Seal | 49,000 | 0 | 0.0% |

Abundance sources: COSEWIC (2004), Boveng et al. (2009), Cameron et al. (2010), Allen and Angliss (2012)

# 7.0 ANTICIPATED IMPACT OF THE ACTIVITY ON THE SPECIES OR STOCK

## 7.1 Introduction

The primary impact of the proposed OBC seismic survey to local marine mammals is acoustical harassment from the 880 and 1,760 cubic inch airgun operations. Noise generated from the airguns could disrupt normal behaviors of marine mammals where received levels exceed 160 dB re 1 µPa. What is known about behavioral responses to noise stimuli by the marine mammals that inhabit the OBC seismic survey area are discussed below. Acoustical injury is possible where received sound levels exceed 180 dB re 1 µPa (cetaceans) or 190 dB re 1 µPa (pinnipeds), but this potential impact will be mitigated by ramping up of airguns and establishing a shutdown safety zone (see Section 1.2 and Appendix B).

## 7.2 Behavioral Response

***Bowhead and Gray Whales*** - Bowhead whales, and other baleen whales such as gray and humpback whales, have shown strong overt reactions to seismic airguns. Feeding bowhead whales have shown avoidance behaviors at received levels between 160 and 170 dB re 1 µPa (rms) (Richardson et al. 1986, Ljungblad et al. 1988, Miller et al. 2005), but responses have been quite variable. Similarly, McCauley et al. (2000) found resting female humpbacks to remain 7 to 10 kilometers (4 to 6 miles) away from seismic survey operations, while males appeared to be attracted. Malme et al. (1985, 1986) found significant proportions of gray whales summering in the Bering Sea to cease feeding when exposed to seismic received levels between 162 and 173 re 1 µPa (rms). Migrating bowhead whales appear even more sensitive to impulsive noises and often deviate from their migration course after exposure to noise less than 160 dB re 1 µPa (rms), and at distances 20 to 30 kilometers (12 to 19 miles) from the source (Miller et al. 1999, Richardson et al. 1999). Still, deviating whales still remain well within the general migration corridor, and there is no evidence of long-term effects from seismic noise exposure. Bowhead populations continued to substantially increase in the 1970s and 1980s even in the presence of considerable seismic survey and other oil and gas activities (Richardson et al. 1987).

***Beluga Whales*** – There is some suggestive information that beluga whales actively avoid seismic operations (Miller et al. 2005), but additional information is sparsely available on this species. Vessel-based seismic operations occur during the Arctic open water period when most belugas are in the pack ice or calving lagoons. Studies on the effects of seismic surveys on other odontocetes have observed varied results. Toothed whales often appear to avoid seismic operations at times (e.g., Calambokidis and Osmek 1998, Stone 2003), and are attracted to them at other times. Studies by Finneran et al. (2003, 2005) showed that captive beluga whales and bottlenose dolphins showed adverse reactions to sounds of similar duration as seismic arrays, but that they were less sensitive to noise levels. Romano et al. (2004) found elevated stress hormones in captive belugas exposed to playbacked seismic water gun sounds, while Thomas et al. (1990) did not find elevated stress hormones in belugas exposed to drilling playback sounds. Odontocetes are adapted to receiving and vocalizing high frequency sounds and, therefore, may be less sensitive to lower frequency impulse sounds from drilling noises and seismic airguns.

***Ringed, Spotted, and Bearded Seals*** – Pinnipeds in general appear somewhat tolerant of airguns, partially because they can escape underwater pressure levels by exposing their head above the water surface, and their lesser sensitivity to lower frequency noises. Several Alaskan studies (Harris et al. 2001, Moulton and Lawson 2002, Miller et al. 2005) noted that ringed seals frequently did not avoid areas within a few hundred meters of operating airgun arrays. However, telemetry studies by Thompson et al. (1998) suggest that spotted and bearded seals may be less tolerant of even small active airgun arrays than visual studies have suggested. Regardless, seal reactions to seismic activities have been temporary and of short duration; there is no evidence of long-term effects. In general, pinnipeds appear to be more tolerant to loud noise activities than cetaceans as evidenced by their tolerance to acoustical harassment devices designed to drive them away. In her review of the known effects of noise on marine mammals, Weilgart (2007) largely confined her discussion on cetaceans and only once mentioned a possible negative effect on pinnipeds.

## 7.3 Temporary Threshold Shift and Permanent Threshold Shift

Noise has the potential to induce temporary (temporary threshold shift [TTS]) or permanent (permanent threshold shift [PTS]) hearing loss (Weilgart 2007). The level of loss is dependent on sound frequency, intensity, and duration. Similar to masking, hearing loss reduce the ability for marine mammals to forage efficiently, maintain social cohesion, and avoid predators (Weilgart 2007). For example, Todd et al. (1996) found an unusual increase in fatal fishing gear entanglement of humpback whales to coincide with blasting activities, suggesting hearing damage from the blasting may have compromised the ability for the whales to use sound to passively detect the nets. Experiments with captive bottlenose dolphins and beluga whales found that short duration impulsive sounds can cause TTS (Finneran et al. 2002).

## 7.4 Masking

Masking occurs when louder airgun noises interfere with marine mammal vocalizations or ability to hear natural sounds in their environment (Richardson et al. 1995), which limit their ability to communicate or avoid predation or other natural hazards. Masking is of special concern for mysticetes that vocalize at low frequencies over long distances, as their communication frequencies overlap with anthropomorphic noises such as shipping traffic and seismic airgun frequencies. Some baleen whales have adjusted their communication frequencies, intensity, and call rate to limit masking effects. For example, McDonald et al. (2009) found that California blue whales have shifted their call frequencies downward by 31 percent since the 1960s, possibly in an attempt to communicate below shipping noise frequencies. Melcon et al. (2012) found blue whales to increase their call rates in the presence of shipping noise, but to significantly decrease call rates when exposed to mid-frequency sonar. Also, Di Iorio and Clark (2010) found blue whales to communicate more often in the presence of seismic survey, which they attributed to compensating for an increase in ambient noise levels. Fin whales have reduced their calling rate in response to boat noise (Watkins 1986), and were thought to stop singing altogether for weeks in response to seismic surveys (IWC 2007).

# 8.0 THE ANTICIPATED IMPACT OF ACTIVITY ON AVAILABILITY OF SPECIES OR STOCKS OF MARINE MAMMALS FOR SUBSISTENCE USES

The proposed seismic activities will occur within the marine subsistence area used by the village of Nuiqsut. Nuiqsut was established in 1973 at a traditional location on the Colville River providing equal access to upland (e.g., caribou, Dall sheep) and marine (e.g., whales, seals, and eiders) resources (Brown 1979). Although Nuiqsut is located 40 kilometers (25 miles) inland, bowhead whales are still a major fall subsistence resource. Although bowhead whales have been harvested in the past all along the barrier islands, Cross Island is the site currently used as fall whaling base as it includes cabins and equipment for butchering whales. However, whalers must travel about 160 kilometers (100 miles) to annually reach the Cross Island whaling camp which is located over 110 direct kilometers (70 miles) from Nuiqsut. Whaling activity usually begins in late August with the arrival whale migrating from the Canadian Beaufort Sea, and may occur as late as early October depending on ice conditions and quota fulfillment. Most whaling occurs relatively near (<16 kilometers; <10 miles) the island, largely to prevent meat spoilage that can occur with a longer tow back to Cross Island. Since 1993, Cross Island hunters have harvested one to four whales annually, averaging three.

Cross Island is located 70 kilometers (44 miles) east of the eastern boundary of the seismic survey box. (Point Barrow is over 160 kilometers [100 miles] outside the potential survey box.) Seismic activities are unlikely to affect Barrow or Cross Island based whaling, especially if the seismic operations temporarily cease during the fall bowhead whale hunt.

Although Nuiqsut whalers my incidentally harvest beluga whales while hunting bowheads, these whales are rarely seen and are not actively pursued. Any harvest would occur would most likely in association with Cross Island.

The potential seismic survey area is also used by Nuiqsut villagers for hunting seals. All three seal species – ringed, spotted, and bearded – are taken. Sealing begins in April and May when villagers hunt seals at breathing holes in Harrison Bay. In early June, hunting is concentrated at the mouth of the Colville River where ice breakup flooding results in the ice thinning and seals becoming more visible. Once the ice is clear of the Delta (late June), hunters will hunt in open boats along the ice edge from Harrison Bay to Thetis Island in a route called "round the world". Thetis Island is important as it provides a weather refuge and a base for hunting bearded seals. During the July and August ringed and spotted seals are hunted in the lower 65 kilometers (40 miles) of the Colville River proper.

In terms of pounds, approximately one-third of the village of Nuiqsut's annual subsistence harvest is marine mammals (fish and caribou dominate the rest), of which bowhead whales contribute by far the most (Fuller and George 1999). Seals contribute only 2 to 3 percent of annual subsistence harvest (Brower and Opie 1997, Brower and Hepa 1998, Fuller and George 1999). Fuller and George (1999) estimated that 46 seals were harvested in 1992. The more common ringed seals appear to dominate the harvest although the larger and thicker skinned bearded seals are probably preferred. Spotted seals occur in the Colville River Delta in small numbers, which is reflected in the harvest.

Available harvest records suggest that most seal harvest occurs in the months preceding the July start of seismic survey when waning ice conditions provide the best opportunity to approach and kill hauled out seals. Much of the late summer seal harvest occurs in the Colville River as the seals follow fish runs upstream. Still, open water seal hunting could occur coincident with the seismic surveys, especially bearded seal hunts based from Thetis Island. In general, however, given the relatively low contribution of seals to the Nuiqsut subsistence, and the greater opportunity to hunt seals earlier in the season, the seismic survey impact to seal hunting is likely remote. Impacts to seal populations in general are also very small. Responses of seals to seismic airguns are expected to be negligible. Bain and Williams (2006) studied the responses of harbor seals, California sea lions, and Steller sea lions to seismic airguns and found that seals at exposure levels above 170 dB re 1 µPa (peak-peak) often showed avoidance behavior including generally staying at the surface and keeping their heads out of the water, but that the responses were not overt, and there were no detectable responses at low exposure levels.

## 9.0 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE HABITAT OF THE MAMMAL POPULATIONS AND THE LIKELIHOOD OF RESTORATION OF THE AFFECTED HABITAT

The OBC seismic survey area will occur on the Beaufort Sea coastal shelf ecoregion. The physical habitat is characterized as a nearshore, shallow water (0 to 18 meters deep) flat with a mostly mud or sandy mud bottom substrate (Smith 2010). The marine resources associated with this habitat important to local marine mammals include the fish, invertebrates, and zooplankton these cetaceans forage upon.

Beluga whales, ringed seals, and spotted seals feed primarily on fish. Trawl studies conducted in the Beaufort Sea have shown a clear dominance of the fish community by Arctic cod (*Boreogadus saida*) with locally high populations of capelin (*Mallotus villosus*) (Frost and Lowry 1983, Craig 1984, Cannon et al. 1987, Jarvela and Thorsteinson 1999, Logerwell et al. 2010). Other fish ranking in the community include eelpouts (*Lycodes* spp.), snailfish (*Liparis* spp.), and sculpins (Frost and Lowry 1983, Logerwell et al. 2010), with Arctic cisco (*Coregonus autumnalis*) common along the brackish shorelines (Jarvela and Thorsteinson 1999). Jarvela and Thorsteinson (1999) commented on the relatively low richness in fish species diversity in the Alaskan Beaufort Sea.

Bearded seals feed on fish as well, but their diet is largely dominated by invertebrates (Cameron et al. 2010). Carey et al. (1984) sampled the bivalve population in the project vicinity (near Pingok Island) and found a relatively high abundance of about a dozen species of small clams. One species, *Macoma calcarea*, does grow to sizes exceeding 50 millimeters and may be consumed by local bearded seals. Snow crabs (*Chionoecetes opilio*) are also an important prey item (Cameron et al. 2010), but their presence (or any crab presence for that matter) is unknown in the seismic survey box. Snow crabs, however, are becoming increasingly abundant near Point Barrow (Logerwell et al. 2010) and may be expanding eastward in the Beaufort Sea.

In the Alaskan Beaufort Sea, bowhead whales feed largely on euphausiid and calanoid copepod zooplankton (Moore et al. 2010). These resources are high near Point Barrow where feeding studies have been conducted, but much lower east of Barrow (Smith 2010). Most of the Alaskan bowhead whale population feeds in the Canadian Beaufort Sea during the summer months, and these whales are more likely to migrate through the seismic survey area than stop to feed. Based on stomach contents from whales harvested during the fall migration, bowheads don't appear to feed during migration except near Point Barrow (Moore et al. 2010). Further, seismic impacts to zooplankton are unknown, but if similar to larval fish, then injury impacts (>220 dB) from the seismic airguns would extend out only 2 or 3 meters from the source (Davis et al. 1998).

Project activities that could potential impact marine mammal habitats include laying cable on sea bottom and acoustical injury of prey resources. There are few benthic resources in the survey area that could be impacted by cable-laying, and the nearshore benthic environment is highly resilient given the annual ice scour (Lewis and Blasco 1990). Reimnitz et al. (1977) estimated that the Alaskan Beaufort seabed between 6 and 14 meters depth is completely reworked by ice scour every 50 years. Compared to annual ice scour, cable impacts are considered insignificant.

Relative to fish and crab prey resources, the primary habitat concerns are acoustical effects on Arctic cod, capelin, Arctic cisco, and snow crabs. Christian et al. (2003) studied seismic energy impacts on male snow crabs and found no significant increases in physiological stress due to exposure. No acoustical impact studies have been conducted to date on the above fish species, but studies have been conducted on Atlantic cod and sardine. Davis et al. 1998 cited various studies found no effects to Atlantic cod eggs, larvae, and fry when received levels were 222 dB. What effects were found were to larval fish within about 5 meters, and from airguns with volumes between 3,000 and 4,000 cubic inches. Similarly, effects to sardine were greatest on eggs and 2-day larvae, but these effects were greatest at 0.5 meters, and again confined to 5 meters. Further, Greenlaw et al. (1988) found no evidence of gross histological damage to eggs and larvae of northern anchovy exposed to seismic airguns, and concluded that noticeable effects would result only from multiple, close exposures. Based on these results, the 880 to 1,760 cubic inch airguns planned for the SAE Beaufort survey could damage larval fish, but only out to about 2 or 3 meters at most. From an ecological community standpoint, these impacts are considered minor.

Overall, cable laying and acoustical effects on prey resources will have a minor effect at most on the marine mammal habitat within the seismic survey area. Some prey resources might be temporarily displaced, but no long-term effects are unexpected.

## 10.0 THE ANTICIPATED IMPACT OF THE LOSS OR MODIFICATION OF THE HABITAT ON THE MARINE MAMMAL POPULATIONS INVOLVED

Based on the conclusions of Section 9 above, no loss or modification of marine mammal habitat is expected. Any impacts to prey resources is considered minor or negligible, and no long-term effects would occur.

## 11.0 AVAILABILITY AND FEASIBILITY OF EQUIPMENT, METHODS, AND MANNER OF CONDUCTING ACTIVITY OR OTHER MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACT UPON THE AFFECTED SPECIES OR STOCKS, THEIR HABITAT, AND ON AVAILABILITY FOR SUBSISTENCE USES

The primary means of minimizing potential impacts to marine mammals include 1) using relative small seismic arrays (1,760, 880, and 440 cubic inch) with sound sources much less than typical 3D seismic arrays, 2) establishing shutdown safety zones to ensure marine mammals are not injured by noise levels exceeding Level A injury thresholds, 3) conducting the surveys outside the seal pupping season, and 4) shutting operations down or moving them inland during the period the main vanguard of migrating bowhead whales pass through the Beaufort Sea. Reducing and mitigating potential acoustical impacts to local marine mammals during seismic activity is fully addressed in the Marine Mammal Monitoring and Mitigation Plan attached as Appendix B.

## 12.0 LOCATION OF PROPOSED ACTIVITY – IN OR NEAR A TRADITIONAL ARCTIC SUBSISTENCE HUNTING AREA AND IMPACT ON AVAILABILITY OF SPECIES OR STOCK OF MARINE MAMMALS FOR ARCTIC SUBSISTENCE USES

SAE is conducting the planned seismic surveys in a joint partnership agreement with Kuukpik Corporation. As a joint venture partner with Kuukpik, SAE will be working closely with them and the communities on the North Slope to plan operations that will include measures that are environmentally suitable and that do not impact local subsistence use. A Conflict Avoidance Agreement will be developed that will include such measures. A schedule of meetings in the villages of Nuiqsut, Barrow, Kaktovik, and any other affected communities will be developed and meetings attended

As described in Section 8, both bowhead whales and seals contribute to the subsistence of the coastal villages along the Beaufort Sea, with bowhead whales the far more important of the two. Pt. Barrow occurs over 160 kilometers (100 miles) west and Cross Island 70 kilometers (44 miles) east of the survey box, both well beyond the distance where seismic generated noise is expected to reach ambient (20 kilometers).

The seismic survey area also falls within areas that are used to hunt seals by the villagers of Nuiqsut. However, most of this sealing occurs during freeze up, right at break up, or when the ice edge is nearby, all prior to the open-water period when seismic surveys would occur. Summer hunting for seals largely occurs in the Colville River proper as seals follow fish runs 65 kilometers (40 miles) upstream. The most likely concern is bearded seal hunting from Thetis Island, which can occur during the open water period. The potential impacts to this hunt will be addressed during the conflict avoidance process.

## 13.0 SUGGESTED MEANS OF ACCOMPLISHING THE NECESSARY MONITORING AND REPORTING THAT WILL RESULT IN INCREASED KNOWLEDGE OF THE SPECIES, THE LEVEL OF TAKING OR IMPACTS ON POPULATIONS OF MARINE MAMMALS THAT ARE EXPECTED TO BE PRESENT WHILE CONDUCTING ACTIVITIES AND SUGGESTED MEANS OF MINIMIZING BURDENS BY COORDINATING SUCH REPORTING REQUIREMENTS WITH OTHER SCHEMES ALREADY APPLICABLE TO PERSONS CONDUCTING SUCH ACTIVITY.

Monitoring and reporting potential acoustical impacts to local marine mammals are fully addressed in the Marine Mammal Monitoring and Mitigation Plan attached as Appendix B.

## 14.0 LEARNING, ENCOURAGING, AND COORDINATING RESEARCH OPPORTUNITIES, PLANS, AND ACTIVITIES RELATING TO REDUCE AND EVALUATE INCIDENTAL "TAKE"

Potential impacts of seismic noise on marine mammals have been studied, with the results used to establish the noise criteria for evaluating take and to support shutting down seismic operations during the whale hunt. Opportunity to further evaluate seismic effects on bowhead whales is largely not available as seismic operations will be shut down when most bowheads are present in the seismic area. However, all observations of marine mammals, including any observed reactions to the seismic operations will be recorded and reported to NMFS and the North Slope Borough.

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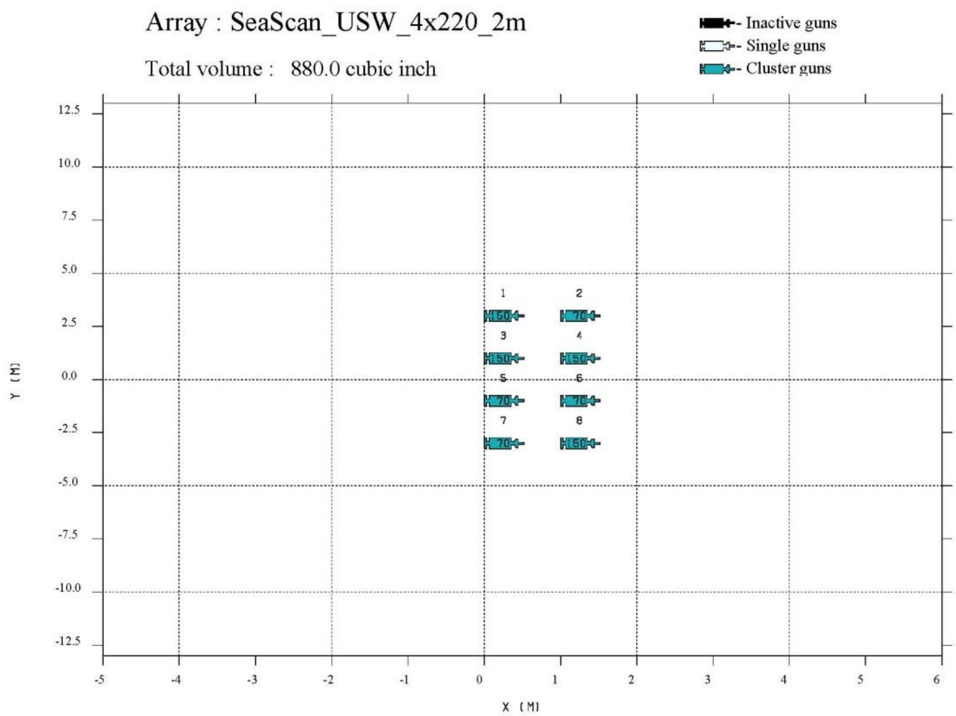
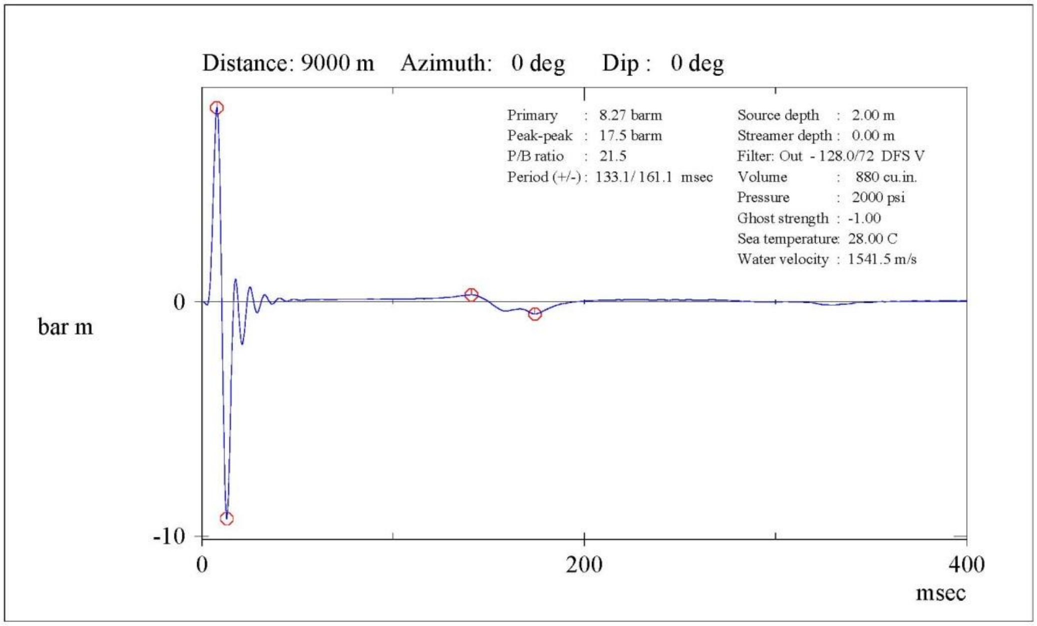
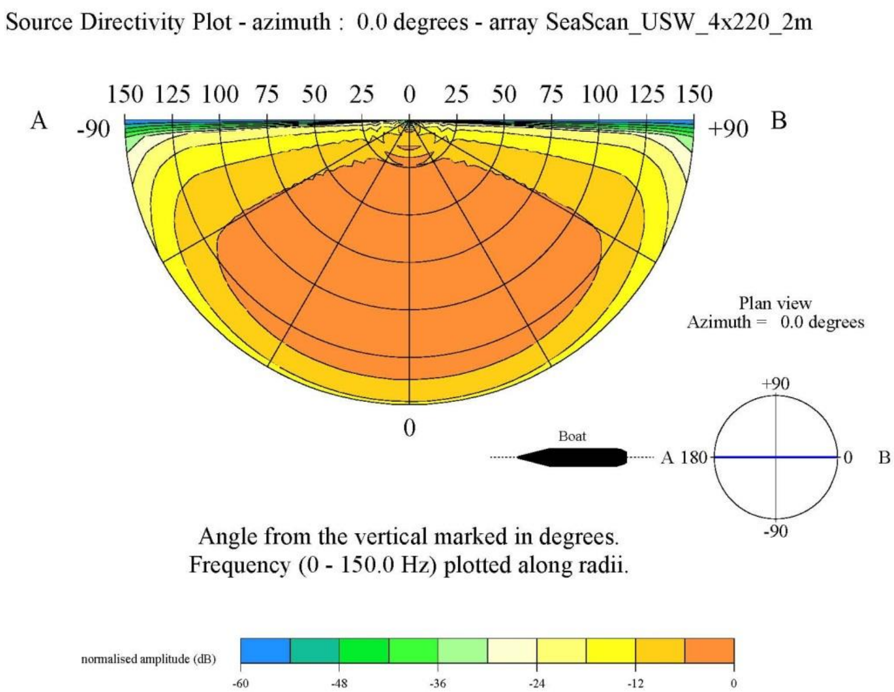
## Appendix A

## The 1,760 and 880 cui Array Configurations, Far-field Signatures, and Directivity Plots

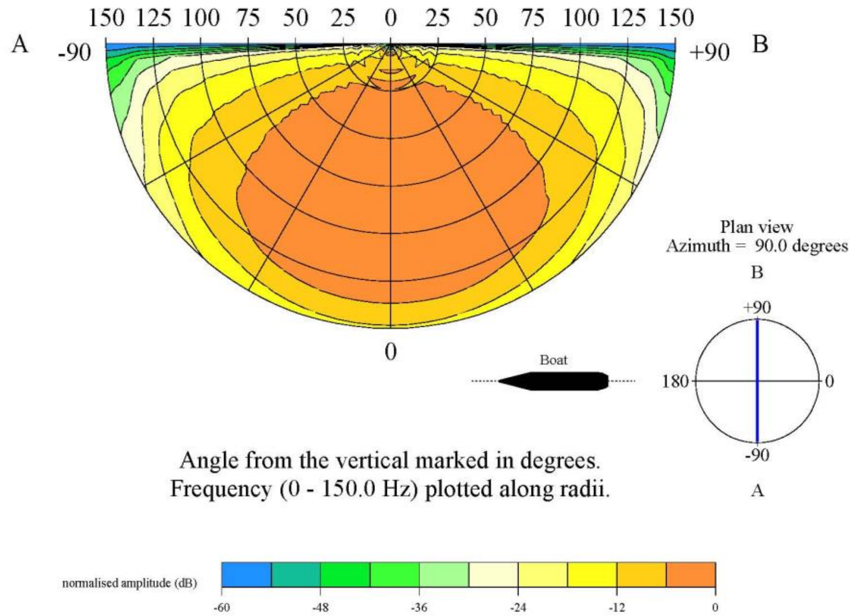

Array : SeaScan_USW_4x220_2m
Total volume : 880.0 cubic inch
Inactive guns
Single guns
Cluster guns
Y (M)
X (M)

Farfield signature : SeaScan_USW_4x220_2m

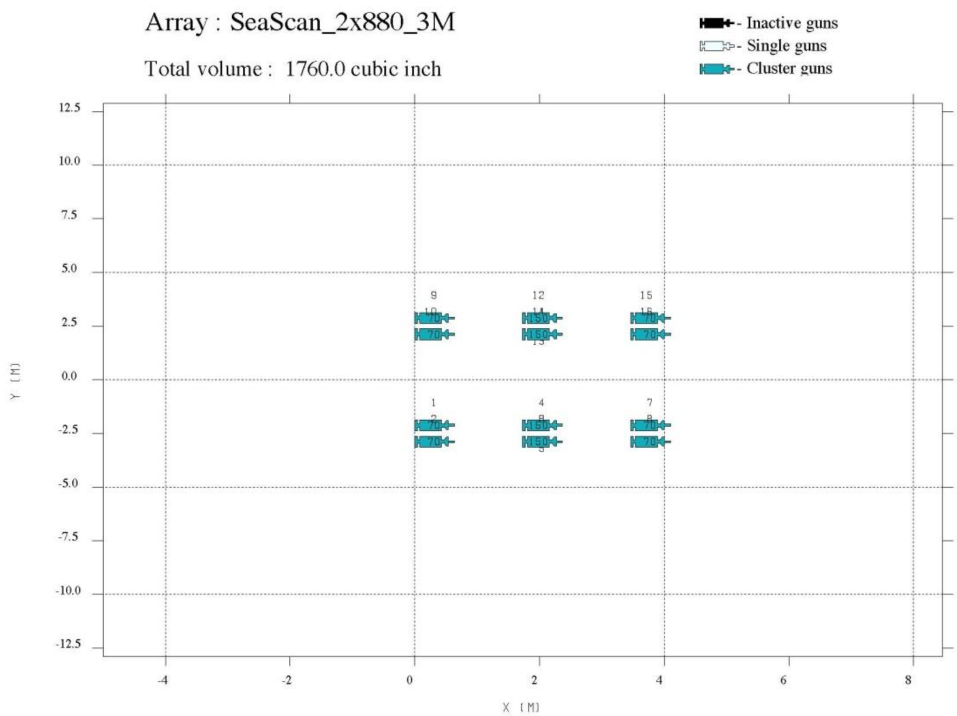



Source Directivity Plot - azimuth : 0.0 degrees - array SeaScan_USW_4x220_2m
150 125 100 75 50 25 0 25 50 75 100 125 150
A
-90
+90
B
0
Plan view
Azimuth = 0.0 degrees
+90
Boat
A 180
0
B
-90
Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.
normalised amplitude (dB)
-60
-48
-36
-24
-12
0

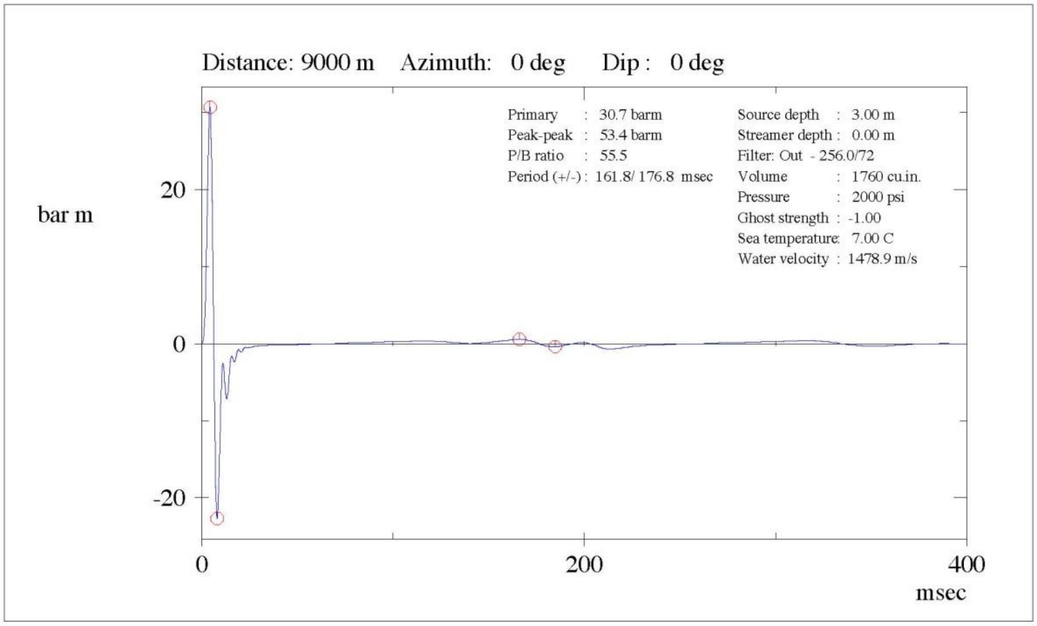
Source Directivity Plot - azimuth : 90.0 degrees - array SeaScan_USW_4x220_2m



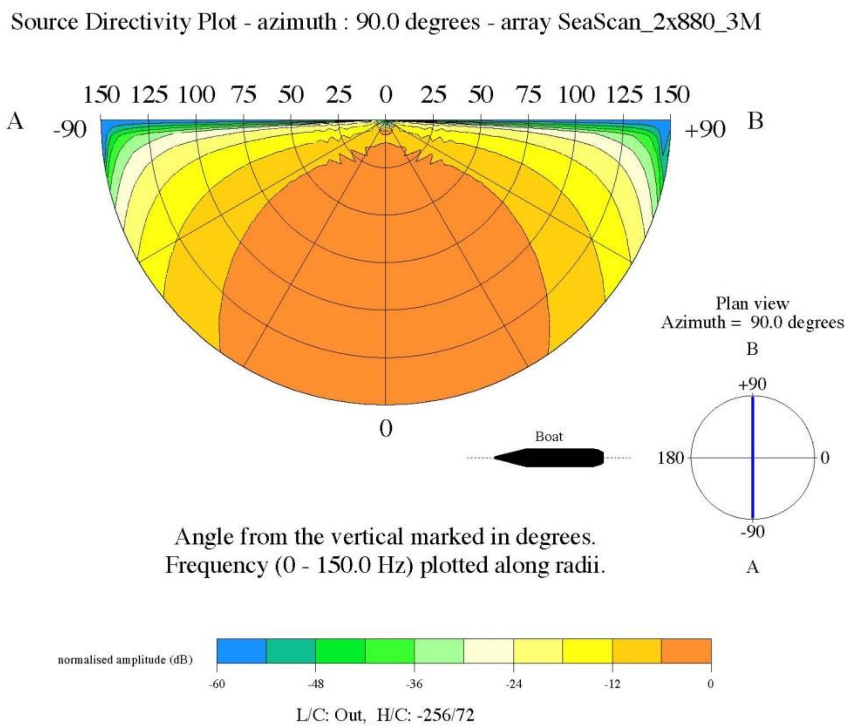

Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.


Array : SeaScan_2x880_3M
Total volume : 1760.0 cubic inch
- Inactive guns
- Single guns
- Cluster guns
Y (M)
X (M)

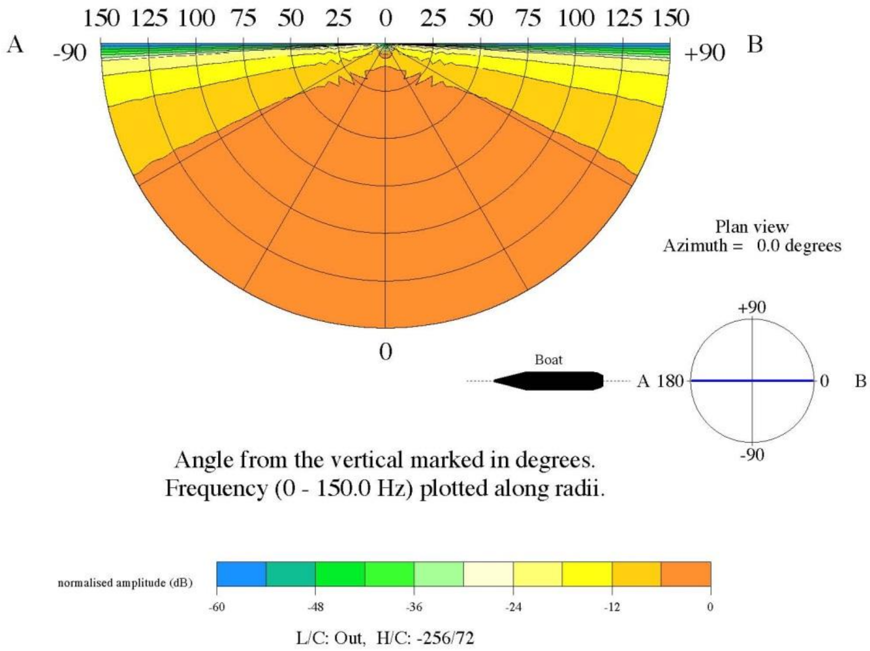
Farfield signature : SeaScan_2x880_3M

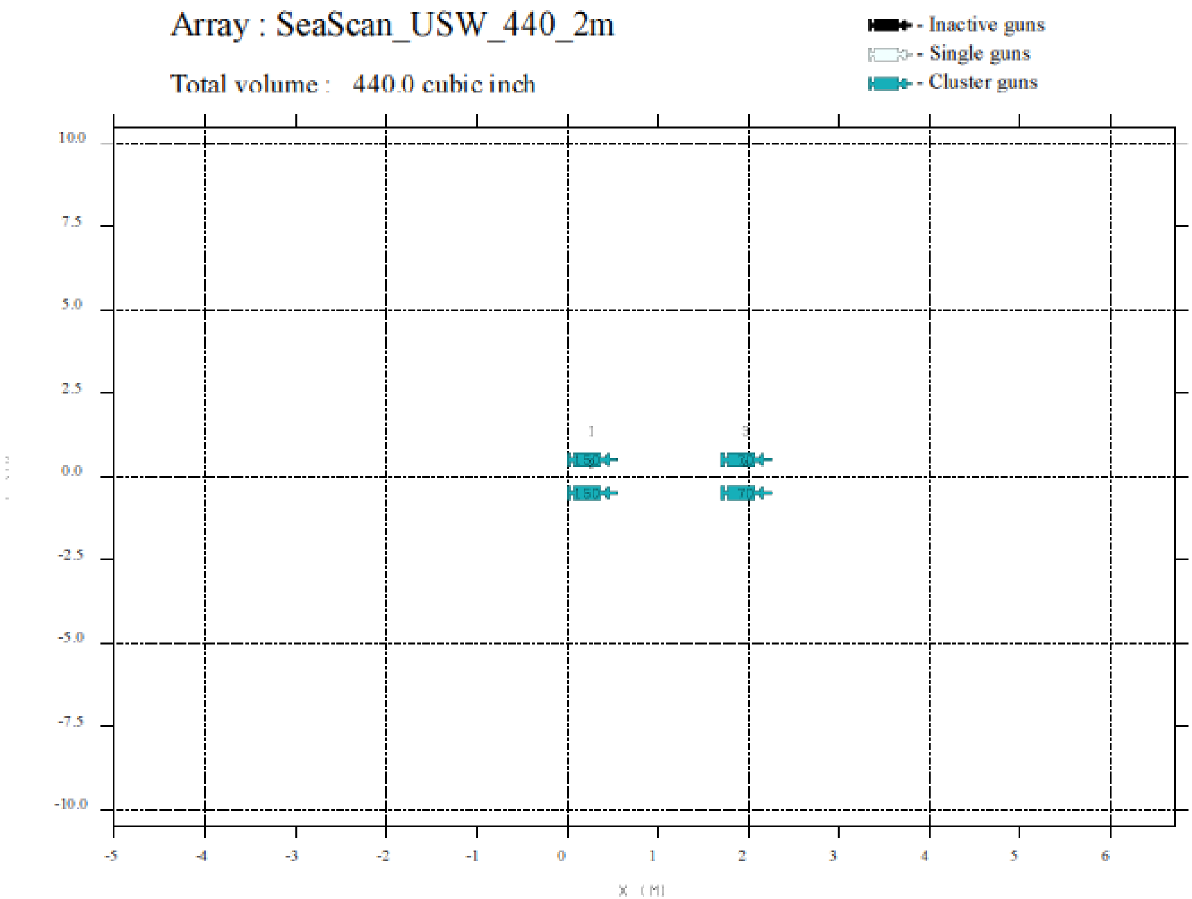



L/C: Out, H/C: -256/72

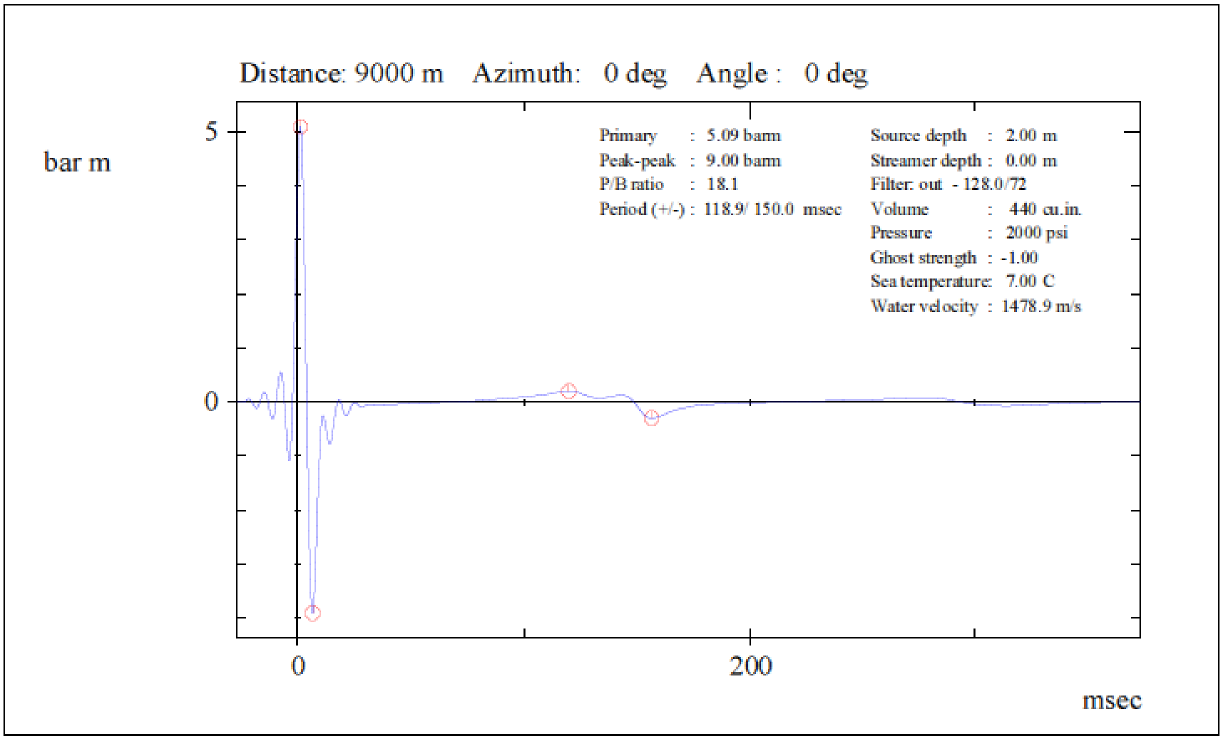

Source Directivity Plot - azimuth : 90.0 degrees - array SeaScan_2x880_3M
150 125 100 75 50 25 0 25 50 75 100 125 150
A
-90
+90
B
0
Plan view
Azimuth = 90.0 degrees
B
+90
180
0
-90
A
Boat
Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.
normalised amplitude (dB)
-60
-48
-36
-24
-12
0
L/C: Out, H/C: -256/72

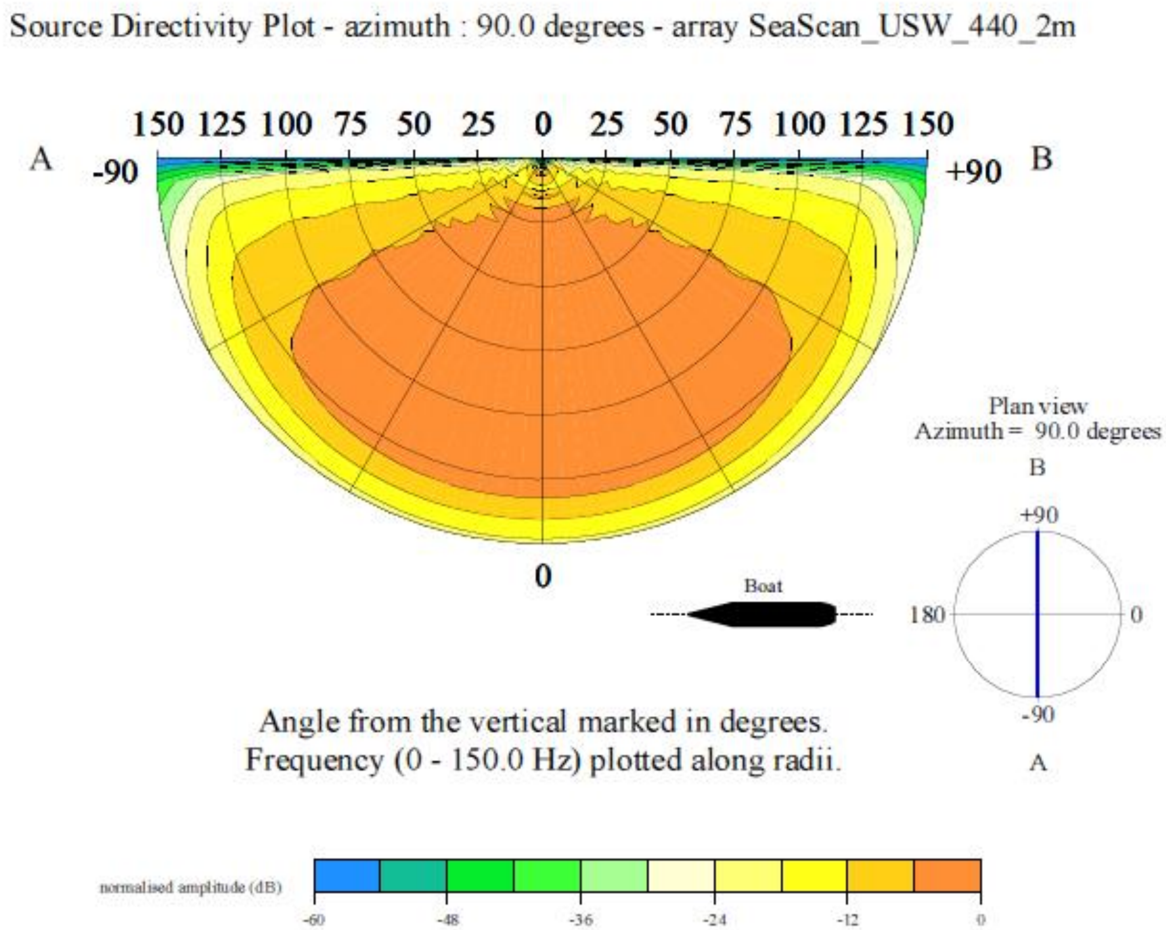
Source Directivity Plot - azimuth : 0.0 degrees - array SeaScan_2x880_3M

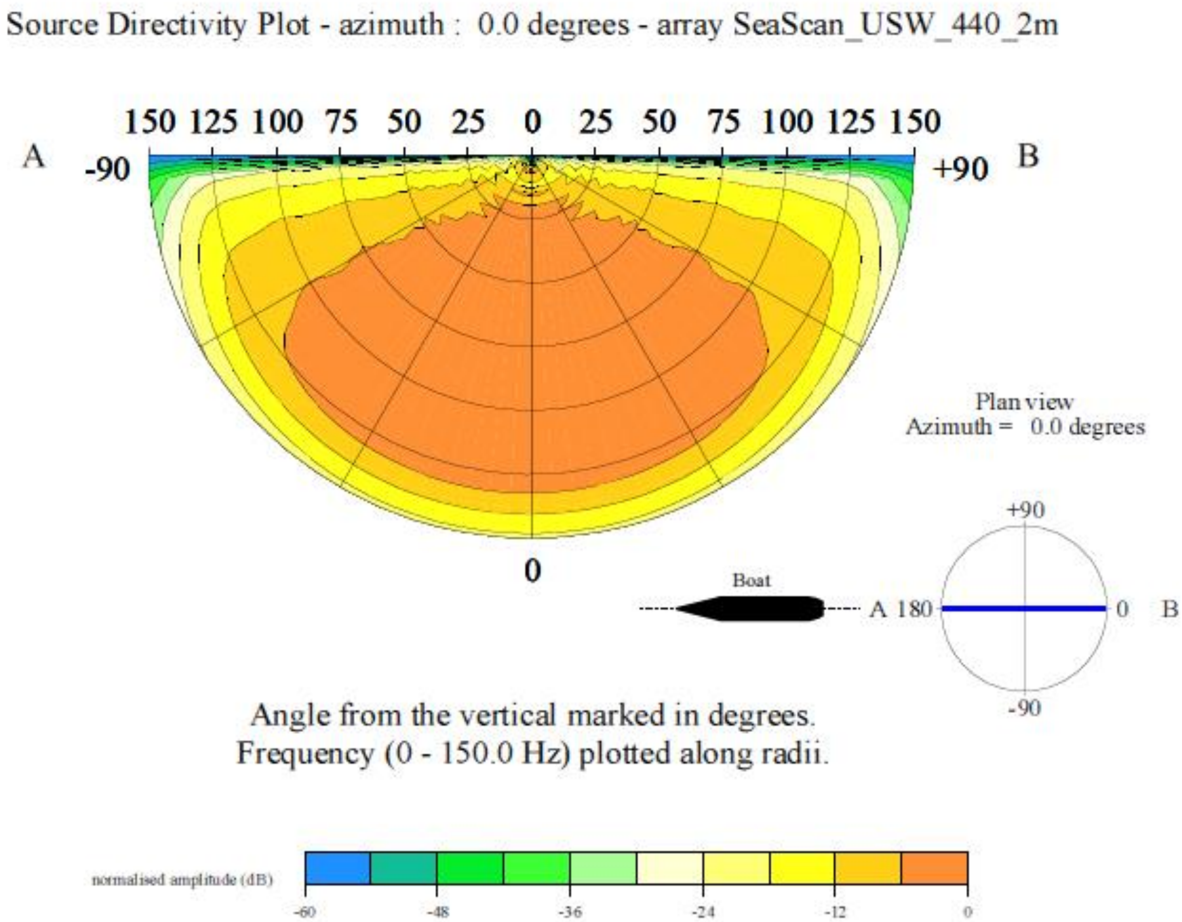



Array : SeaScan_USW_440_2m
Total volume :   440.0 cubic inch
- Inactive guns
- Single guns
- Cluster guns
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
1
3
X (M)

Far-field signature of array : SeaScan_USW_440_2m




Source Directivity Plot - azimuth : 90.0 degrees - array SeaScan_USW_440_2m
150 125 100 75 50 25 0 25 50 75 100 125 150
A -90
+90 B
0
Plan view
Azimuth = 90.0 degrees
B
+90
180
0
-90
A
Boat
Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.
normalised amplitude (dB)
-60 -48 -36 -24 -12 0


Source Directivity Plot - azimuth : 0.0 degrees - array SeaScan_USW_440_2m
150 125 100 75 50 25 0 25 50 75 100 125 150
A
-90
+90
B
0
Plan view
Azimuth = 0.0 degrees
+90
Boat
A 180
0
B
-90
Angle from the vertical marked in degrees.
Frequency (0 - 150.0 Hz) plotted along radii.
normalised amplitude (dB)
-60
-48
-36
-24
-12
0

## Appendix B

## Marine Mammal Monitoring and Mitigation Plan

# Marine Mammal and Monitoring Mitigation Plan

## *SAExploration Colville 3D Seismic Survey Operations - 2013*

### Introduction

SAExploration (SAE) proposed marine mammal monitoring and mitigation plan for the proposed Colville (Beaufort Sea) seismic exploration program is described below. SAE understands that this monitoring and mitigation plan will be subject to review by NMFS, the North Slope Borough, and the Alaska Eskimo Whaling Commission, and others, and that refinements may be required. In order to avoid any takes by injury (Level A), SAE will employ NMFS approved Protected Species Observers (PSOs) to monitor and implement mitigation measures. PSOs will monitor both from the seismic vessels and from a dedicated mitigation vessel to provide both early warning of approaching migrating whales and to assist in monitoring the 160 dB harassment zone..

### Proposed Safety and Harassment Monitoring Radii

PSOs will establish and monitor a safety zone for cetaceans and pinnipeds surrounding the airgun array on the source vessel where the received level would be 180 dB and 190 dB. PSOs will establish and monitor a harassment zone for bowhead and gray whales surrounding the airgun array on the source vessel where the received level would be 160 dB. Whenever aggregations of bowhead whales or gray whales that appear to be engaged in non-migratory significant biological behavior (e.g. feeding, socializing) are observed during a vessel monitoring program within the 160-dB harassment zone around the seismic activity, the seismic operation will not commence or will shut down.

Preliminary monitoring zones for the 190, 180, and 160 dB with the various airgun configurations were estimated. These estimates are provided in Table 1. SAE proposes to monitor these zones for marine mammals before, during, and after the operation of the airguns. Monitoring will be conducted using qualified PSOs on vessels. All the preliminary monitoring zones will be adjusted as needed based on the results of the sound source verification test (see below).

**Table 1. Summary of Distance to NMFS Sound Level Thresholds**

| Source | Source Level | 190 dB | 180 dB | 160 dB |
|---|---|---|---|---|
| 440 cubic inch airgun array | 221.08 dB re 1 µPa (rms) | 126 m | 325 m | 1.33 km |
| 880 cubic inch airgun array | 226.86 dB re 1 µPa (rms) | 167 m | 494 m | 1.5 km |
| 1,760 cubic inch airgun array | 236.55 dB re 1 µPa (rms) | 321 m | 842 m | 2.99 km |

## Sound Source Verification

A sound source verification (SSV) test is planned to be conducted for this project as soon as the first seismic surveys commence. The SSV will be conducted by an acoustical firm with prior experience conducting SSV tests in Alaska. The methodology to be used will be provided to NMFS prior to testing to ensure the results meet the agency's expectations. The results of the test will be used to establish and monitor new 180-dB and 190-dB marine mammal safety zones, and the 160-dB harassment zone. Results of the SSV will be available and implemented within 72 hours of the completion of the test.

## Visual Vessel-Based Monitoring

The vessel-based monitoring will be designed to cover the requirements of the Incidental Harassment Authorization for this project. The objectives of the vessel-based monitoring will be to:

- ensure that disturbance to marine mammals is minimized and all permit stipulations are followed;
- document the effects of the proposed seismic activities on marine mammals; and
- collect data on the occurrence and distribution of marine mammals in the proposed project area.

The monitoring and mitigation plan will be implemented by a team of experienced PSOs, including both biologists and Inupiat communicators. PSOs will be stationed aboard source and mitigation vessels to monitor and implement mitigation measures during all daytime seismic operations. A lead PSO will be designated on the source and mitigation vessel for effective communication and to oversee the monitoring and mitigation program. With NMFS consultation, PSOs will be hired by SAE. PSOs will follow a schedule so observers will monitor marine mammals near the seismic vessel during all ongoing operations and air-gun ramp ups. PSOs will normally be on duty in shifts no longer than 4 hours and no more than a total of 12 hours per day.

Source vessels will employ PSOs to identify marine mammals during all hours of air gun operations. One PSO will be on the source vessels and two PSOs on the support vessel in order to better observe the exclusion zone. When marine mammals are about to enter or are sighted within designated exclusion zones, air gun operations will be shut down immediately. The vessel-based observers will watch for marine mammals at the seismic operation during all periods of source effort and for a minimum of 30 minutes prior to the planned start of air gun or pinger operations after an extended shut down. SAE vessel crew and operations personnel will also watch for marine mammals (insofar as practical) to assist and alert the observers for the air gun(s) to be shut down if marine mammals are observed in or about to enter the exclusion zone. Seismic operations will not be initiated or continue when adequate observation of the designated applicable exclusion zone is not possible due to environmental conditions such as high sea state, fog, ice and low light. Termination of seismic operations will be at the discretion of the lead PSO based on continual observation of environmental conditions and communication with other PSOs.

The source and support vessels are suitable platform for marine mammal observations. When stationed on the flying bridge, the observer will have an unobstructed view around the entire vessel. If surveying from the bridge, the observer's eye level will be about 6 meters (20 feet) above sea level. During operations, the PSO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 and 16-40x80) and with the naked eye. Laser range finders (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. Range finders will be used for training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly.

All observations and air gun shut downs will be recorded in a standardized format. Data will be entered into a custom database using a notebook computer. The accuracy of the data entry will be verified daily by the lead PSOs by a manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, or other programs for further processing and archiving.

The vessel-based observation will provide:

- the basis for real-time mitigation, if necessary, as required by the IHA;
- information needed to estimate the number of “ Level B takes” of marine mammals by harassment, which must be reported to NMFS;
- data on the occurrence, distribution, and activities of marine mammals in the areas where the seismic operations are conducted;
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the source vessels at times with and without seismic activity;
- a communication channel to coastal communities including Inupiat whalers; and
- employment opportunities for local residents and development/experience for Inupiat Communicators and PSOs.

## Mitigation Measures

### Shut-Down Procedure

A shut-down occurs when all air gun activity is suspended. The operating air gun(s) will be shut down completely if a marine mammal approaches the applicable exclusion zone. The shutdown procedure will be accomplished within several seconds (of a “one shot” period) of the determination that a marine mammal is either in or about to enter the applicable exclusion zone.

The operations will not proceed with air gun activity until the marine mammal has cleared the zone and the trained PSOs on duty are confident that no marine mammals remain within the appropriate exclusion zone. The animal will be considered to have cleared the exclusion zone if it:

- Is visually observed to have left the applicable exclusion zone;
- Has not been seen within the zone for 15 min in the case of pinnipeds;
- Has not been seen within the zone for 30 min in the case of cetaceans.

### Power Down Procedure

Whenever a marine mammal is detected outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion zone, PSOs may request that the seismic operations implement a power down (de-energize the airgun array). A power down procedure involves reducing the number of air guns in use such that the radius of the 180 dB (or 190 dB) zone is decreased to the extent that marine mammals are not in the exclusion zone. Alternatively, a shutdown procedure occurs when all air gun activity is suspended. During a power down, a mitigation air gun (air gun of small volume such as the 10 cu in) is operated. If a marine mammal is detected outside the safety radius (either injury or harassment) but is likely to enter that zone, the air guns may be powered down before the animal is within the safety radius, as an alternative to a complete shutdown.

Similar to a shutdown, after a power down, air gun activity will not resume until the marine mammal has cleared the applicable exclusion zone. The animal will be considered to have cleared the applicable exclusion zone if it:

- is visually observed to have left the applicable exclusion zone, or
- has not been seen within the zone for 15 min in the case of pinnipeds, or
- has not been seen within the zone for 30 min in the case of cetaceans.

### Ramp Up Procedure

A “ramp up” procedure gradually increases air gun volume at a specified rate and involves a step increase in the number and total volume of airguns until the full volume is achieved. The purpose of the ramp up or “soft start” is to warn marine mammals potentially in the area and provide sufficient time for them to leave the project area and avoid any potential injury. Ramp up is used at the start of air gun operations, including a power down, shut down, and after any period greater than 10 minutes in duration without air gun operations. The air gun array begins operating after a specified-duration period without air gun operations. The rate of ramp up will be no more than 6 dB per 5 minute period. Ramp up will begin with the smallest gun in the array that is being used for all air gun array configurations. During the ramp up, the applicable exclusion zone for the full air gun array will be maintained.

If the complete applicable exclusion zone has not been visible for at least 30 minutes prior to the start of operations, ramp up will not start unless the mitigation gun has been operating during the interruption of seismic survey operations. This means that it will not be permissible to ramp up the full source from a complete shut-down in thick fog or at other times when the outer part of the applicable exclusion zones are not visible.

It will not be permissible to commence ramp-up if the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime and not commence ramp-up at night unless the seismic source has maintained a sound source pressure level at the source of at least 180 dB during the interruption of seismic survey operations.

### Speed or Course Alteration

Whenever a marine mammal is detected outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion zone, PSOs may request that the seismic operations implement an alternative ship speed or track. If a marine mammal is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course may, when practical and safe, be changed that also minimizes the effect on the seismic operations. This can be used in coordination with a power down procedure. The marine mammal activities and movements relative to the seismic and support vessels will be closely monitored to ensure that the marine mammal does not approach within the applicable exclusion zone. If the mammal appears likely to enter the exclusion zone, further mitigation actions will be taken; for example, either further course alterations, power down, or shut down of the air gun(s).

As an additional mitigation procedure, with or without seismic operations taking place, SAE proposes to reduce vessel speed when within 1 kilometer of whales and those vessels capable of steering around such groups will do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group. Vessel captains will avoid multiple changes in direction and speed when within 1 kilometer of whales.

## Protected Species Observers

Vessel-based monitoring for marine mammals will be done by trained PSOs throughout the period of seismic operations to comply with expected provisions in the IHA and CAA. The observers will monitor the occurrence and behavior of marine mammals near the source and mitigation vessels during all daylight periods during operation, and during most daylight periods when seismic operations are not occurring. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the seismic acquisition operations; and documenting exposures of animals to sound levels that may constitute harassment as defined by NMFS.

### Number of Observers

PSO teams will consist of Inupiat observers and experienced field biologists. An experienced field crew leader and an Inupiat observer will be members of every PSO team onboard the source and mitigation vessel during the seismic acquisition program. Inupiat PSOs will also function as Native language communicators with hunters and whaling crews and with the Communications and Call Centers (Com Centers) in Native villages along the Beaufort Sea coast.

A sufficient number of PSOs will be required onboard each seismic vessel and the mitigation vessel to meet the following criteria:

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

### PSO Role and Responsibilities

When onboard the seismic and support vessels, there are three major parts to the PSO position:

1) Observe and record sensitive wildlife species.
2) Ensure mitigation procedures are followed accordingly.
3) Follow monitoring and data collection procedures.

The main roles of the PSO and the monitoring program are to ensure compliance with regulations set in place by NMFS and other agencies to ensure that disturbance of marine mammals is minimized, and potential effects on marine mammals are documented. The PSOs will implement the monitoring and mitigation measures specified in the NMFS issued IHA and in this 4MP. The primary purposes of the PSOs on board of the vessels are:

- Mitigation: Implement mitigation clearing and ramp up measures, observe for and detect marine mammals within, or about to enter the applicable safety radii and implement necessary shut down, power down and speed/course alteration mitigation procedures when applicable. Advise marine crew of mitigation procedures.
- Monitoring: Observe for marine mammals and determine numbers of marine mammals exposed to sound pulses and their reactions (where applicable) and document those as required.

The PSOs will observe for marine mammals, stationed at the best available vantage point on the source and support vessels. Ideally this vantage point is an elevated stable platform such as the bridge or flying bridge from which the PSO has an unobstructed 360 degree view of the water. The observer(s) will scan systematically with the unaided eye and 7x50 reticle binoculars, supplemented with 16-40x80 long-range binoculars and night-vision equipment when needed. New or inexperienced PSOs will be paired with an experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

The following information about marine mammal sightings will be carefully and accurately recorded:

- species, group size, age/size/sex categories (if determinable);
- physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
- behavior when first sighted and after initial sighting, heading (if consistent);
- bearing and distance from observer, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace;
- time, location, speed, and activity of the source and mitigation vessels, sea state, ice cover, visibility, and sun glare; and positions of other vessel(s) in the vicinity.

## Aerial Monitoring

Aerial monitoring will not be conducted as part of this program. The monitoring radius (distance to the 160-dB isopleth) is 3 kilometers, and should be easily covered by observers aboard the seismic vessels with support from the PSOs aboard the mitigation vessel. In addition, the seismic operations will be suspended or altered (*e.g.,* working in nearshore waters well downstream of Cross Island) during the bowhead whale hunt, which is coincident with the bulk of the bowhead whale fall migration through the potential seismic survey area. Actively avoiding migrating bowhead whales coupled with using the smaller airgun arrays should eliminate the need for aerial monitoring.

## Measures to Reduce Impacts to Subsistence Users

In-water seismic activities will follow mitigation procedures to minimize effects on the behavior of marine mammals and; therefore, opportunities for subsistence harvest by Alaska Native communities. These include:

- Inupiat Communicators and Inupiat PSOs will record marine mammal observations along with marine mammal biologists during the monitoring program and be provided annual reports.
- Fully implement the measures consistent with the CAA.
- Participate with other operators in the Communications Call Centers (Com-Center) Program. The Com-Centers will be operated 24 hours/day during the 2013 subsistence bowhead whale hunt. SAE proposes to routinely call the communications center according to the established protocol while in the Beaufort Sea.

## Reporting

A final report will be submitted to NMFS within 90 days after the end of the project. The report will describe the operations that were conducted and the marine mammals that were observed. The report will include documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities, marine mammal behavior and any observed behavioral changes).