INCIDENTAL HARASSMENT AUTHORIZATION REQUEST FOR THE NON-LETHAL HARASSMENT OF MARINE MAMMALS DURING THE LIBERTY UNIT SHALLOW GEOHAZARD SURVEYS, BEAUFORT SEA, ALASKA, 2015

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Submitted by

Hilcorp Alaska, LLC
3800 Centerpoint Drive
Suite 1400
Anchorage, AK 99503

Prepared by:

ERM Alaska, Inc.
825 West 8th Avenue
Anchorage, Alaska 99501
T: (907) 258-4880
F: (907) 258-4033

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1. DETAILED OVERVIEW OF OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of whales and seals.

Hilcorp Alaska, LLC (Hilcorp) plans to conduct a shallow geohazard survey and Strudel Scour survey with a transition zone component on state lands, and in federal and state waters of Foggy Island Bay in the Beaufort Sea during the open water season of 2015. The scope of this request is limited to the activities that will be conducted during the 2015 open water evaluation of the proposed Liberty field development. The project area lies mainly within the Liberty Unit (Liberty), (**Figure 1**). Hilcorp requests an Incidental Harassment Authorization (IHA) allowing non-lethal harassment of marine mammals incidental to the proposed 2015 shallow geohazard surveys. This application for an IHA is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a)(5). The proposed 2015 shallow geohazard survey has been optimized for completion in one season. This section provides operational details of the proposed shallow geohazard survey. Information on the dates, duration, and project area are being provided in Section 2.

1.1. Purpose

Hilcorp is evaluating development of the Liberty field. The Liberty reservoir is located in federal waters in Foggy Island Bay about 8 miles (mi) east of the Endicott Satellite Drilling Island (SDI). The project's preferred alternative is to build a gravel island situated over the reservoir. In support of the preferred alternative, a shallow geohazard survey is planned with an emphasis on obtaining subsurface information for the development of a subsea pipeline. The sonar survey, using multibeam echosounder, sidescan sonar, sub-bottom profiler, and magnetometer is planned over the proposed subsea pipeline corridor area. The purpose of this proposed survey is to evaluate the existence and location of archaeological resources, potential geologic hazards on the seafloor and in the shallow subsurface, and to investigate strudel scours and ice gouges.

1.2. Project Details

The proposed Liberty pipeline route open water survey will consist of the shallow geohazard and strudel scour / ice gouge surveys. Data will be acquired along the subsea pipeline corridor area (**Figure 2**) using the single-beam or multibeam echosounder, side scan sonar, sub-bottom profilers, and the magnetometer as described below.

The Liberty shallow geohazard survey will comply with NTL No. 05-A02 pursuant to regulations at 30 CFR 250.201, 30 CFR 250.1007(a), and 30 CFR 250.1010 July 25, 2005.

1.2.1. Equipment and Personnel Mobilization and Demobilization

Mobilization and demobilization activities are primarily planned to occur at West Dock.

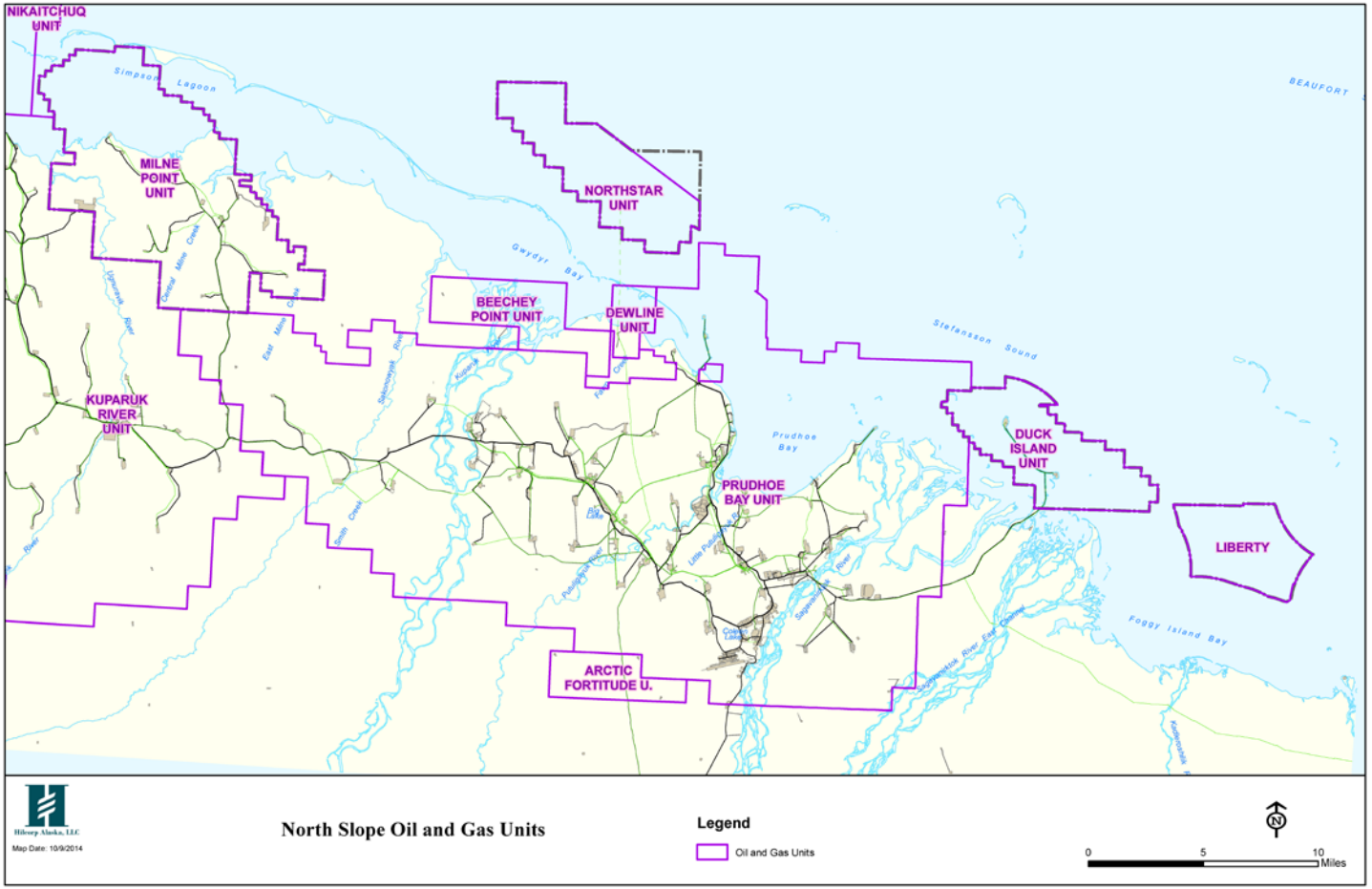

Figure 1. Overview of the eastern Beaufort Sea with the outline of the Liberty Unit.

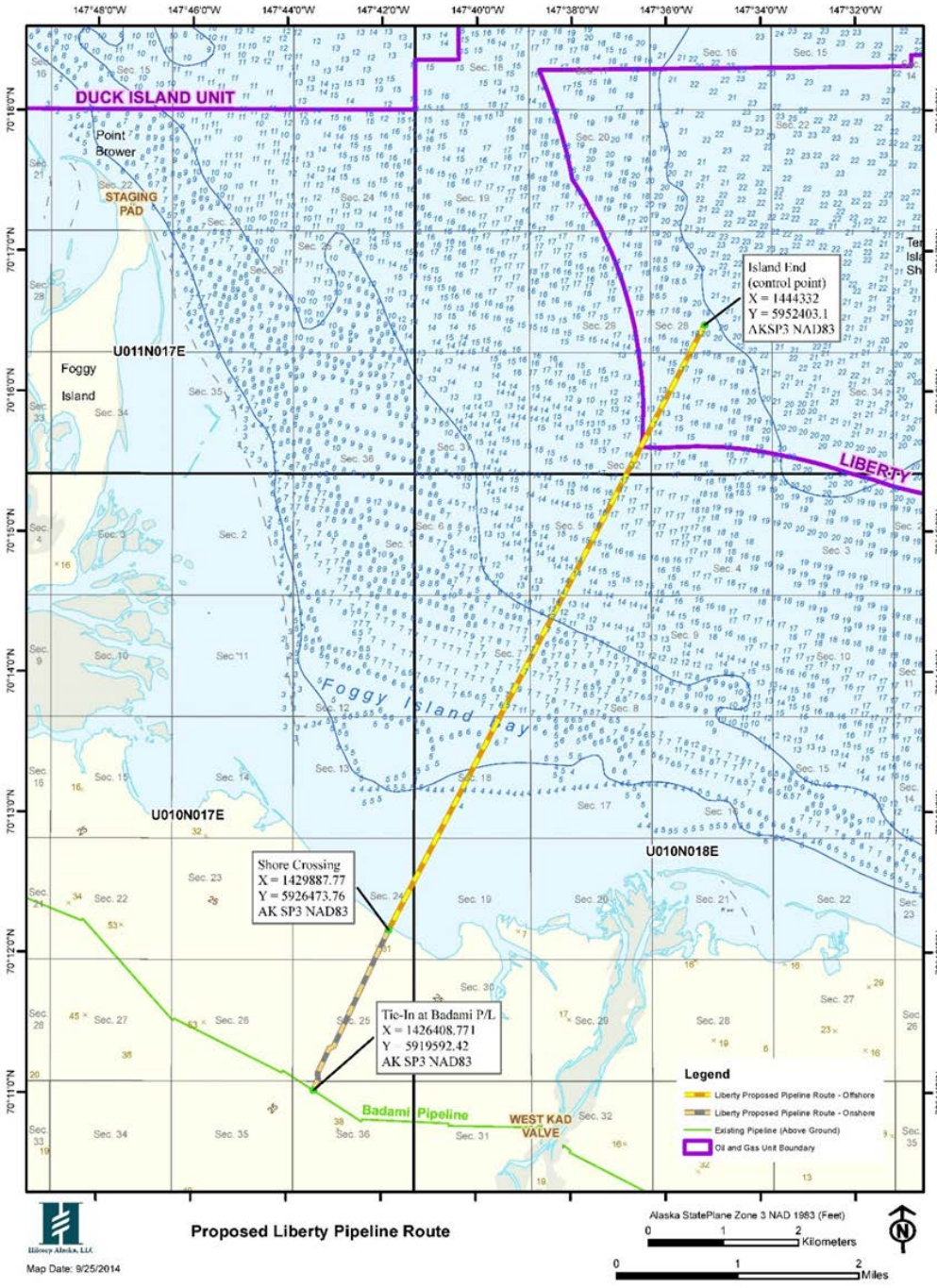

Figure 2. Overview of the Proposed Liberty Unit Pipeline Route.

1.2.2. Vessel Mobilization

One main vessel will be used for the geohazard survey. The proposed survey vessel (M/V Sidewinder or equivalent) is about 40 x 14 ft. in size and will travel at approximately 3 knots during data acquisition. This vessel is currently stationed on the North Slope and will be prepared and launched at West Dock. Vessel preparation includes the assembly and installation of navigation, acoustic, and safety equipment. Once assembled, the navigation and acoustic systems will be tested and calibrated at West Dock or at the project site.

Because of the extremely shallow project area, additional small vessel(s) may be utilized to safely extend vessel operations for data collection. This will most likely comprise of a small skiff or inflatable craft with limited crew and range. Small craft operations will be supported by the larger vessel (**Table 1**).

Table 1 Summary of Vessels and Other Equipment Involved in Proposed 2015 Liberty Unit Sonar Survey

VESSEL TYPE	NUMBER (approx.)	DIMENSIONS (approx.)	MAIN ACTIVITY	FREQUENCY
OFFSHORE AND SURFZONE				
M/V Sidewinder or equivalent	1	40 x 14 ft.	Sonar Survey	24-hr operation
Small boat (possibly a Zodiac)	1-2		Strudel Scour and Sonar Surveys in Shallow Water	24-hr operation

1.2.3. Navigation and Data Management

Each survey vessel will be equipped with a GPS receiving differential corrections from a variety of possible sources, including a shore-based kinematic base station.

Tidal corrections will be determined through GPS computation, comparison with any local tide gauges, or, if available, with tide gauges operated by other projects.

A navigation software package will display known obstructions, islands, and identified areas of sensitivity. The software will also show the pre-determined survey line plans. The information will be updated as necessary to ensure required data coverage. The navigation software will also record all measured equipment offsets and corrections, and vessel and equipment position at a frequency of no less than once per second during acoustic equipment operation.

1.2.4. Housing and Logistics

Approximately 10 people will be involved in the operation. Most of the crew will be accommodated at existing camps and some crew will be housed on the vessel. Support activities, such as crew transfers and vessel re-supply are primarily planned to occur at West Dock. Equipment staging and on shore support will primarily occur at West Dock. For protection

from weather, the vessel may anchor near West Dock, near the barrier islands, or other safe harbor, near shore locations.

1.2.5. Data Acquisition

Equipment that will be used for the proposed shallow geohazard survey includes single-beam or multibeam echosounder, side scan sonar, sub-bottom profilers, and magnetometer. Details related to data acquisition are summarized below. Any substitution of the equipment will be in accordance with IHA requirements.

1.2.6. Survey Design

The proposed sonar survey vessel (M/V Sidewinder or equivalent) is about 40 x 14 feet in size. The sub-bottom profilers and magnetometer will be deployed from the vessel. The echosounder and side scan sonar will be hull-mounted. No equipment will be placed on the sea floor as part of survey activities. Because of the extremely shallow project area, additional small vessel(s) may be utilized to safely extend vessel operations for data collection.

The total planned survey lines are approximately 300 miles, not including turns and cross-lines. The project area is 2.5 mi^2 in water depths ranging from 3 to 20 ft. The open water pipeline route geohazard and strudel scour / ice gouge survey period is expected to take approximately 45 days to complete, including weather and equipment change out downtime. About 25% of downtime is included in this total, so the actual number of days that equipment are expected to be operating is estimated at 34, based on a continuous 24-hr operation. Data will be acquired along the subsea pipeline corridor area (**Figure 2**) using the single-beam or multibeam echosounder, side scan sonar, sub-bottom profilers, and the magnetometer. Because of the shallow nature of the project area and small size of the vessel, systems will be towed in optimal groupings that best facilitate safe operations and data quality. As necessary, a small vessel may be used to extend data collection into shallow waters. Planned survey lines will be designed to acquire 150% side scan sonar data coverage or as mandated, with line spacing dependent upon water depth. A 300 m corridor around the centerline of the proposed pipeline area will be covered.

<u>Multibeam echo sounder and side scan sonar</u>

A single-beam or multibeam echosounder and side scan sonar will be used to obtain high accuracy information regarding bathymetry of the seafloor. For accurate object detection, a side scan sonar survey is required to complement a multibeam echosounder survey.

The proposed multibeam echosounder operates at an rms source level of a maximum of 220 dB re 1 µPa @1m. The multibeam echosounder emits high frequency (240 kHz) energy in a fan-shaped pattern of equidistant or equiangular beam spacing (**Table 2**). The beam width of the emitted sound energy in the along-track direction is 1.5 degrees, while the across track beam width is 1.8 degrees. The maximum ping rate of the multibeam echosounder is 40 Hz.

The proposed single-beam echosounder operates at an rms source level of approximately 220 dB re 1 µPa @1m (**Table 2**). The transducer selected uses a frequency of 210 kHz and has a ping rate of up to 20 Hz. The transducer's beam width is approximately 3 degrees.

The proposed side scan sonar system will operate at about 400 kHz and 900 kHz. The rms source level is 215 dB re 1µPa @1m. The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beam width of 0.45 degrees for 400 kHz and 0.25 degrees at 900 kHz, with a vertical beam width of 50 degrees (**Table 2**). The maximum ping rate is 75 Hz.

Sub-bottom profiler

The proposed high-resolution sub-bottom profiler operates at an rms source level of 210db re 1 µPa @1m. The proposed system emits energy in the frequency bands of 2 to 24 kHz. The beam width is 15 to 24 degrees (**Table 2**). Typical pulse rate is between 3 and 10 Hz.

The proposed low-resolution sub-bottom profiler operates at an rms source level of 212db re 1 µPa @1m. This secondary sub-bottom profiler will be utilized as necessary to increase sub-bottom profile penetration. The proposed system emits energy in the frequency bands of 1 to 4 kHz.

Magnetometer

A marine magnetometer will be used for the detection of magnetic deflection generated by geologic features and buried or exposed ferrous objects which may be related to archaeological artifacts or modern man-made debris. The magnetometer will be towed at a sufficient distance behind the vessel to avoid data pollution by the vessel's magnetic properties. Magnetometers passively measure changes in magnetic fields over the seabed and do not impact marine mammals.

The strudel scour / ice gouge bathymetric survey will be conducted in concurrence with the Shallow Hazard survey work planned for the open water season. The primary objective will be to obtain detailed bathymetric and side scan sonar data at each of the strudel drainage sites located previously during spring survey work. In addition, a search for relict strudel scours and ice gouges along the pipeline route will be conducted by obtaining bathymetric and side scan sonar data on up to five survey lines centered on the pipeline alignment and with offset located within 1000 ft. of the alignment. Equipment that will be used for the strudel scour and ice gouge survey will include multi-beam sonar (to obtain detailed bathymetric data in deep water), single-beam sonar (to obtain bathymetric data in shallow water and serve as a back-up to the multi-beam system in deep water), and side scan sonar (to locate ice gouges, strudel scours, and hard-bottom targets).

Table 2. Source characteristics of the proposed geophysical survey equipment to be used during the Liberty geohazard survey.

EQUIPMENT	Sample Equipment Model Type	OPERATING FREQUENCY	ALONG TRACK BEAM WIDTH	ACROSS TRACK BEAM WIDTH	RMS SOURCE PRESSURE LEVEL (Directional) Re 1 µPa @1m
Multibeam echosounder	Reson 7101 SV[a]	240 kHz	1.5°	1.8°	220 dB
Single-beam echosounder	Odom[b]	210 kHz	3°	3°	220 dB
Side scan sonar	Edgetech 4125[c]	400 kHz/900 kHz	0.5°	50°	215 dB
High resolution (CHIRP) sub-bottom profiler	Edgetech 3200[d]	2 to 24 kHz	15° to 24°	15° to 24°	210 dB
Low resolution sub-bottom profiler	Applied Acoustics AA251[e]	1 to 4 kHz	n/a	n/a	212 dB

[a] Verbal conversation with Kelly Wright, engineer with Teledyne Reson 12/3/14, and Equipment Specification document "SeaBat(r) 7101".

[b] Computed using equation for source level of directional circular transducer. Principles of Underwater Sound, Chapter 2, Robert J. Urick, 1975, and Equipment Specification document "SMBB200-3 information sheet".

[c] Edgetech document "4125 source level specification" received via email from Edgetech representative Rob Morris on 7/1/2014, and Equipment Specification document "Edgetech 4125 Side Scan Sonar System".

[d] Edgetech document "3200 SB system transmit level" received via email from Edgetech representative Rob Morris on 7/1/2014, and Equipment Specification document "Edgetech 3200 Sub-bottom Profiling System".

[e] Equipment Specification document "AA251, AA301 Boomer Seismic Sound Source".

2. DATES, DURATION AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

Hilcorp seeks incidental harassment authorization for the period July 1 to September 30, 2015. The survey will commence with mobilization of equipment to Deadhorse by truck. The survey is expected to take approximately 45 days to complete, including weather and equipment downtime.

The project area of the proposed Liberty shallow geohazard survey lies within Foggy Island Bay as shown in **Figure 1**. Activity outside the area delineated on **Figure 2** may include vessel turning, vessel transit, and other vessel movements for project support and logistics. The approximate boundary of the survey area is between 70°12’0”N and 70°17’0”N and between 147°32’0”W and 147°46’0”W.

To limit potential impacts to the bowhead whale migration and the subsistence hunting, operations dates will be in accordance with the dates agreed to in the Conflict Avoidance Agreement (CAA); all sonar activities will cease August 25 when whale hunting traditionally begins. Demobilization of equipment is planned to be complete before the end of September.

3. SPECIES AND NUMBERS OF MARINE MAMMALS IN THE PROJECT AREA

The species and numbers of marine mammals likely to be found within the area of activity.

Whale and seal species listed in **Table 3** are the subjects of this IHA request to the National Marine Fisheries Service (NMFS). In the U.S., the walrus and polar bear are managed by the U.S. Fish & Wildlife Service (USFWS). A request for a letter of authorization (LOA) to allow incidental non-lethal harassment of Pacific walrus and polar bear during the proposed shallow hazards and strudel scour survey activities in the Foggy Island Bay area will be submitted separately to the USFWS.

The marine mammal species under NMFS jurisdiction that are known to, or may, occur in the Beaufort Sea include eight whale species and four species of seals (**Table 3**). Two whale species, the bowhead and humpback whales, are listed as endangered under the Endangered Species Act (ESA). The bowhead whale is the most common species in the Beaufort Sea, whereas humpback whales are considered extralimital and encounters in the Foggy Island Bay area are therefore not expected. Of the six non-ESA listed whales, the gray whale and beluga are the most commonly occurring species in the Beaufort Sea. The narwhal, killer whale, harbor porpoise, and minke whale are rare or extralimital to the Beaufort Sea and therefore unlikely to be encountered in the Foggy Island Bay area. Abundance estimates of these four extralimital species are not provided in **Table 3** and their status and distribution is only briefly discussed in Section 4.3. The ringed, bearded and spotted seals are the most commonly occurring seal species in the Beaufort Sea. Ribbon seals occur mainly in the Chukchi Sea and western part of the Beaufort Sea and encounters in the Foggy Island Bay area are not expected. NMFS issued the final rule for listing the Bering Sea distinct population segment (DPS) of bearded seals and Arctic stock of ringed seals as threatened under the ESA in December 2012. This rule became effective as of February 26, 2013 for both species (NMFS 2012a, 2012b). NMFS determined not to list the Bering Sea stock of spotted seals and the ribbon seals under the ESA, because they are currently not in danger of extinction or likely to become endangered in the foreseeable future (NMFS 2009, 2013a).

Table 3. Abundance estimates, habitat, and conservation status of marine mammals under NMFS jurisdiction that could or are likely to occur in the Beaufort Sea during the open-water season. Abundance estimates are not provided for species that are rare or extralimital to the Beaufort Sea.

SPECIES	ABUNDANCE[1]	HABITAT	ESA[2]	IUCN[3]
		WHALES		
Bowhead whale (Bering-Chukchi-Beaufort Stock)	12,631	Pack ice, open water coastal and offshore	Endangered	LC
Gray whale (eastern Pacific population)	19,126[4]	Coastal, lagoons	Not listed	LC
Beluga (Beaufort Sea Stock)	39,258	Offshore, ice edge, coastal, lagoons.	Not listed	NT
Minke whale	Rare/Extralimital	Shelf, coastal	Not listed	LC
Humpback whale	Rare/Extralimital	Shelf, coastal	Endangered	LC
Narwhal	Rare/Extralimital	Offshore, ice edge	Not listed	NT
Killer whale	Rare/Extralimital	Variable habitats	Not listed	DD
Harbor Porpoise	Rare/Extralimital	Variable habitats	Not listed	--
		SEALS		
Ringed seal (Beaufort Sea Stock)	300,000[5]	Landfast and pack ice, open water	Threatened	LC
Bearded seal (Bering and Chukchi Sea)	155,000[6]	Pack ice, open water	Threatened	LC
Spotted seal (eastern and central Bering Sea)	141,479[7]	Pack ice, open water, coastal haulouts	Not listed	DD
Ribbon seal (eastern and central Bering Sea)	61,000[8]	Pack ice, open water	Not listed	DD

[1] Abundance estimates are derived from the most recent Alaska Marine Mammal Stock Assessment Reports (Allen and Angliss 2014), unless otherwise noted.

[2] U.S. Endangered Species Act of 1973

[3] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Codes for IUCN classifications version 3.1: EN = Endangered; NT = Near Threatened; LC = Least Concern; DD = Data Deficient, and -- = not yet assessed. http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1#categories.

[4] Estimate based on 2006/2007 data (Laake et al. 2012).

[5] The estimate presented in Kelly et al. (2010a) is based on estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000. This is not considered a reliable abundance estimate, is likely an underestimate, and is based on surveys of a portion of the range and are greater than 8 years old. A reliable estimate of NMIN for the total population in the Alaskan Chukchi and Beaufort Sea regions is not available. (Allen and Angliss 2014).

[6] Reliable abundance estimates are currently not available (Allen & Angliss 2014). Based on studies by Ver Hoef et al. (2010), Fedoseev (2000) and Bengtson et al. (2005), Cameron et al. (2010) estimated about 125,000 bearded seals in the Bering Sea and 27,000 bearded seals in the Chukchi Sea cited in Angliss and Allen (2014).

[7] Based on Verhoef et al. (in review) cited in Angliss & Allen (2014).

[8] Frequencies of sightings data from the 2007 surveys and information on ice distribution and the timings of seal haulout behavior were analyzed to develop a population estimate in the areas surveyed (Ver Hoef et al. in press). Interim estimate until aerial survey data from 2003, 2007, and 2008 has been analyzed (Allen and Angliss 2014).

4. STATUS AND (SEASONAL) DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

A description of the status, distribution, and seasonal distribution (when applicable) of the species or stocks of marine mammals likely to be affected by such activities

This section contains information on the population status and seasonal distribution of the marine mammal species listed in **Table 3**, based on the most recent data available.

4.1. Whales

4.1.1. Beluga (Delphinapterus leucas)

There are five stocks of belugas (Delphinapterus leucas) in Alaska: the Cook Inlet, Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea stocks (Allen and Angliss 2014). Animals of the Beaufort Sea and eastern Chukchi Sea stocks could potentially occur in the project area. The most recent population estimate for the Beaufort Sea stock is 39,258 individuals and the eastern Chukchi Sea stock is estimated at 3,710 animals (Allen and Angliss 2014). The population trends of both stocks are currently unknown; however, based on available data, there is no evidence that the eastern Chukchi Sea stock is declining (Allen and Angliss 2014).

Seaman et al. (1985) compiled the following distribution information from various sources. In spring, the Beaufort and Chukchi sea stocks of belugas use open leads in the sea ice to migrate from their wintering grounds in the Bering Sea north to their respective summer grounds in the Beaufort and Chukchi seas. Most animals of the Beaufort Sea stock migrate to the Mackenzie River estuary in the Canadian Beaufort Sea where they arrive in April or May, with some animals arriving as early as March or as late as July (Seaman and Burns 1981; Braham and Krogman 1977; Marquette 1976, 1977 and 1979; Frost et al. 1983a). They typically stay there during July and August to molt, feed, and calve. Later in the summer, they spread out, foraging in waters of the eastern Beaufort Sea, Amundsen Gulf, and other northern waters (Davis and Evans 1982; Seaman and Burns 1981). Belugas from the Chukchi Sea stock stay in coastal areas or shallow lagoons, such as the Kasegaluk Lagoon, early in the summer (Frost and Lowry 1990, Frost et al. 1993). Later in the summer (after mid-July) they move offshore to forage in the ice-packed deeper waters along and beyond the continental shelf. Five of 23 belugas fitted with satellite tags in Kasegaluk Lagoon (captured in late June and early July 1998-2002) were tracked north into the Arctic Ocean venturing into 90% pack ice at 79-80°N (Suydam et al. 2005), suggesting that a significant proportion of the population may be at these high latitudes during the mid- to late-summer period. In the fall, the Chukchi and Beaufort Sea stocks both return to their wintering grounds in the Bering Sea (Kleinenberg at al. 1964).

Belugas are often seen migrating in large groups (Braham et al. 1977), probably consisting of smaller, permanent social units, such as nursing groups or family units (Brodie 1989). Belugas feed on a variety of fish and invertebrates, their diet varying by season and location (Burns and

Seaman 1985). In the summer, belugas feed on a variety of schooling and anadromous fish, particularly Arctic cod. Most feeding is done over the continental shelf and in nearshore estuaries and river-mouths (Brooks 1954-1957; Lensink 1961; Frost et al. 1983b; Lowry et al. 1985). Offshore habitats are not utilized extensively during the summer, but that they may be utilized during autumn. These changes correspond with the sharp decrease in abundance of anadromous fish in coastal waters during autumn (Seaman et al. 1985).

In the central and eastern Beaufort Sea, belugas typically migrate in deep offshore waters along the ice edge north of the Alaskan coast (Seaman and Burns 1981, Burns and Seaman 1985). However, groups of belugas have been detected very close to shore in September (Clarke et al. 2011a). Burns and Seaman (1985) suggest that belugas are strongly associated with the ice fringe and that the route of the autumn migration may be mainly determined by location of the drift ice margin. Relatively few beluga sightings have been recorded in the nearshore area of Prudhoe Bay. Opportunistic sightings have been recorded from Northstar Island, the Seawater Treatment Plant facility and Endicott. During the 2008 OBC seismic survey in Foggy Island Bay, three sightings of eight individuals were observed at about 3 miles east of Endicott SDI (Aerts et al. 2008). Observers of the ASAMM aerial survey also recorded more nearshore beluga sightings than historically seen (Clarke et al. 2014). Based on available information, survey crews may encounter belugas in or close to the survey area. However, the chance of such encounters is low during the summer period.

4.1.2. Bowhead Whale (Balaena mysticetus)

Four stocks of bowhead whales are recognized worldwide by the International Whaling Commission for management purposes (Allen and Angliss 2014). The largest of these four stocks, the Western Arctic or Bering-Chukchi-Beaufort (BCB) stock, inhabits Alaskan waters. Historic commercial whaling decreased the bowhead population to approximately 3,000 whales (Woodby and Botkin 1993). Abundance estimates of whales from the BCB stock, before they were overharvested by commercial whaling, were between 10,400 to 23,000 whales. Since the ban on commercial whaling, the bowhead population has increased steadily as evidenced by the analysis of data collected during 1978-2001 and 2003 - 2005 ice-based counts, acoustic locations, and aerial transects (George et al. 2004; Koski et al. 2010). A figure of the increasing population is included in the 2013 Stock Assessment Report (Figure 42, p. 222 in Allen and Angliss 2014). In 2011, the North Slope Borough (NSB) successfully completed a new ice-based count of bowhead whales, which estimated the population at approximately 16,892 animals, and an annual growth rate of 3.7% (Givens et al. 2013). Although the bowhead whale is recovering well following its decline, it is currently still listed as endangered under the ESA, depleted by the MMPA (Allen and Angliss 2014), and an Alaska Species of Concern with the ADF&G. The Alaska Eskimo Whaling Commission has co-managed this stock with the United States government since the 1980s.

Whales of the BCB stock winter in the Bering Sea and migrate through the Bering Strait, Chukchi Sea, and Alaskan Beaufort Sea to their summer feeding grounds in the Mackenzie River Delta,

Canadian Beaufort Sea. Most bowheads arrive in the coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June, but some remain in the offshore pack ice of the Beaufort Sea until about mid-July. Starting about mid-August through late October, bowheads migrate westwards through the Alaskan Beaufort Sea to their wintering grounds in the central and western Bering Sea (Moore and Reeves 1993; Quakenbush et al. 2010). Late summer and autumn aerial surveys have been conducted in the Alaskan Beaufort Sea since 1979 and have provided useful information on long-term bowhead whale migration and distribution patterns (Ljungblad et al. 1986, 1987; Moore et al. 1989; Monnett and Treacy 2005; Treacy et al. 2006; Clarke et al. 2012, 2013a and 2014). The main migration corridor is located over the continental shelf, typically within 34 miles of shore during years with light to moderate ice conditions (Treacy et al. 2006). Data demonstrate that bowhead whales tend to migrate west in deeper water (farther offshore) during years with higher-than-average ice coverage than in years with less ice. Sighting rates are also lower in heavy ice years. During the fall migration, most bowheads migrate west in water ranging from 50 to 656 ft deep (Miller et al. 2002; Clarke et al. 2012) and few whales have been seen shoreward of the barrier islands in the Alaskan Beaufort Sea. In 2013, however, nearshore sightings appeared more common (Clarke et al. 2014).

Although most bowhead feeding activity occurs in the Canadian Beaufort Sea, feeding activity has also regularly been documented at Point Barrow and, less frequently, in other areas of the Alaskan Beaufort Sea (Richardson and Thomson 2002; Koski et al. 2008, [Bowhead Whale Feeding Ecology Study {BOWFEST} and Aerial Surveys of Arctic Marine Mammals {ASAMM} annual reports available from the NMML web page:

http://www.afsc.noaa.gov/NMML/cetacean/]).

Satellite tagging data showed that some whales were moving back and forth during the summer feeding season between the Alaskan and Canadian Beaufort Sea (Quakenbush et al. 2010). Satellite data from one tagged whale that remained in the central Beaufort Sea for several weeks in July appeared to be associated with at least 14 whales (Clarke et al. 2012).

Bowhead whales may be encountered during the Liberty Unit sonar survey during the summer season, but likely in low numbers and unlikely in the project area. Historically, few bowhead whales have been recorded during the summer season close to shore (e.g., ASAMM 1979-2011 database (available from the NMML web page: http://www.afsc.noaa.gov/NMML/cetacean/)), although this might have coincided with limited survey efforts during this period. During the 2013 ASAMM aerial survey, a larger number of bowhead whales were seen in nearshore waters than would be expected based on historical data (Clarke et al. 2014). Vessel-based observers recorded one multiple species sighting of six animals, consisting of a few bowheads, on 16 August 2013 near Narwhal Island during the OBC Liberty seismic survey (Aerts et al. 2008). During 2008 and 2010 aerial surveys from early July through early October, conducted as part of industrial operations in Harrison and Prudhoe Bay, only a few bowheads were seen before mid-August. None of these whales were close to shore (Christie et al. 2010; Brandon et al. 2011).

Bowhead whales were more commonly observed later in the season, but most animals were seen at distances of more than 15 miles from shore.

4.1.3. Gray Whale (Eschrichtius robustus)

Gray whales (Balaena mysticetus) originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic population is believed to have become extinct by the early 1700s, likely from over harvesting (Mead and Mitchell 1984; Sokolov and Arsen'ev 1994). There are currently two populations of gray whales in the North Pacific Ocean: the eastern North Pacific population, which lives along the west coast of North-America, and the western North Pacific population, which is believed to occur mainly along the coast of eastern Asia (Rice et al. 1984; Swartz et al. 2006) and summers near Sakhalin Island, Russia (Maminov and Blokhin 2004; Nambu et al. 2010, Berzin et al. 1990, Weller et al 1999, Cooke et al. 2008). Recent satellite tagging and photo-identification data conducted by A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences (IEE RAS) and Oregon State University Marine Mammal Institute in collaboration with the U.S. National Marine Fisheries Service, Kronotsky State Nature Biosphere Reserve and the Kamchatka Branch of the Pacific Institute of Geography suggests that there is overlap between the eastern and western populations. The research was contracted through the International Whaling Commission (IWC) and International Union for Conservation of Nature (IUCN) with funding from Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd.

Though populations have fluctuated greatly, the eastern Pacific gray whale population has recovered significantly from commercial whaling, and was delisted from the ESA in 1994. Rugh et al. (2005) estimated the 1997 gray whale population at 29,758 ±3,122. A decline was detected in winter 2001-2002, and estimated at 18,178 ±1,780. The most current population estimate for the gray whale from the 2006/2007 southbound survey is 19,126 (Laake et al. 2012). The NMFS does not consider the eastern Pacific stock of gray whales to be endangered or to be a strategic stock.

The eastern North Pacific population annually migrates from warm wintering ground lagoons in coastal Baja California and Mexico to summer foraging areas in the Bering and Chukchi seas off northern Alaska and Russia (Pike 1962; Rice and Wolman 1971; Bogoslovskaya et al. 1981), primarily between Cape Lisburne and Point Barrow, most often in shallow coastal habitat (Moore et al. 2000). Not all eastern gray whales follow this migration pattern. A small subset of the eastern population feeds in coastal water off of British Columbia, Washington, and Oregon (Patten and Samaras 1977; Sprague et al. 1978). Gray whale calls have been recorded throughout the winter in the Beaufort Sea near Barrow, Alaska, suggesting that some gray whales remain in Arctic waters during this season (Stafford et al. 2007).

Few gray whales have historically been recorded in the Beaufort Sea east of Point Barrow. Hunters at Cross Island took a single gray whale in 1933 (Maher 1960). Gray whales sightings are recorded and are reported in The Bowhead Whale Aerial Survey Project/ASAMM aerial surveys (database available on the NOAA website: http://www.afsc.noaa.gov/nmml/cetacean/bwasp). Several gray whale sightings were reported during both vessel-based and aerial surveys in the

Beaufort Sea in 2006 and 2007 (Jankowski et al. 2009; Lyons et al. 2009). In 2008, a multiple species sighting of six animals consisting of bowhead and gray whales were observed during the Liberty seismic survey in Foggy Island Bay close to Narwhal Island (Aerts et al. 2008). A few gray whales have also been observed in the Canadian Beaufort Sea (Rugh and Fraker 1981), indicating that small numbers have been passing through the Alaskan Beaufort in some years. Given the infrequent occurrence of gray whales in the Beaufort Sea in summer, the probability of encountering gray whales during the Liberty Unit sonar survey is low.

4.2. Seals

4.2.1. Bearded Seal (Erignathus barbatus)

Bearded seals (Erignathus barbatus) have a circumpolar distribution. In Alaska, they occur over the continental shelf waters of the Bering, Chukchi, and Beaufort seas (Burns 1981). There is no reliable estimate of bearded seal abundance in Alaskan waters (Allen and Angliss 2014; Cameron et al. 2010). The abundance in the Bering Sea, based on aerial survey data collected in the central Bering Sea pack ice in 2007, is estimated at ~125,000 (Cameron et al. 2010). In the Chukchi Sea, the number of animals is estimated at ~27,000, based on data from 1999-2000 spring aerial surveys flown along the coast from Shishmaref to Barrow (Cameron et al. 2010). Aerial surveys of the eastern Beaufort Sea, conducted in June during 1974–1979, resulted in an average estimate of 2,100 individuals (Stirling et al. 1982), uncorrected for animals in the water. As the survey area covered roughly half of the ice-covered continental shelf of the western Beaufort Sea, the estimated number of bearded seals in the Beaufort Sea is thought to be 1.5 times 2,100 or ~3,150 (Cameron et al. 2010). Based on these numbers, the Beringia DPS is considered to be ~155,000 bearded seals (Cameron et al. 2010). The NMFS listed the Alaska stock of bearded seals, part of the Beringia distinct population segment, as threatened under the ESA, effective 26 February 2013 (77 CFR 76740).

Bearded seals are closely associated with sea ice, specifically pack ice, particularly during breeding, whelping, nursing, molting and resting periods. Seasonal movements and distribution of bearded seals are therefore linked to seasonal changes in ice conditions. Bearded seals generally move north in late-spring and summer as the ice edge melts and retreats; seals then move south in the fall as sea ice forms to remain associated with their preferred ice habitat (Johnson et al. 1966, Burns 1967, Fay 1974, Burns and Frost 1979, Burns 1981, Simpkins et al. 2003, Frost et al. 2008). As the ice recedes in the spring, bearded seals migrate from their winter grounds in the Bering Sea north through the Bering Strait (mid-April to June) to areas along the margin of the multi-year ice in the Chukchi Sea or to nearshore areas of the central and western Beaufort Sea. Pupping takes place on top of the ice from late-March through May, primarily in the Bering and Chukchi seas. Some pupping occurs on moving pack ice in the Beaufort Sea. Bearded seals do not form herds, although loose aggregations of animals may occur. Spring surveys along the Alaskan coast indicate that bearded seals prefer areas of 70% to 90% sea ice coverage, and are typically more abundant 20-100 nmi from shore than within 20 nmi of shore, with the exception of high concentrations nearshore to the south of Kivalina (Bengtson et al.

2005; Simpkins et al. 2003). Studies indicate that bearded seals generally prefer areas of shallow water along the continental shelf (~ 200 ft. deep) (Stirling et al. 1977, Stirling et al. 1982). As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through the Bering Strait and into the Bering Sea where they spend the winter (Burns and Frost 1979; Frost et al. 2005; Cameron and Boveng 2007, 2009; Frost et al. 2008). This southward migration is less noticeable and predictable than the northward movements in late spring and early summer (Burns 1981; Kelly 1988). Some bearded seals may overwinter in the Chukchi and Beaufort seas, but conditions are likely not as favorable.

Bearded seals have been observed in the survey area. Aerial and vessel-based surveys associated with seismic programs, barging, and government surveys in this area between 2005 and 2010 reported several sightings (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; Clarke et al. 2011a). These seals are expected to be occasionally encountered during the sonar surveys.

4.2.2. Spotted Seal (Phoca largha)

The spotted seal (Phoca largha) is found from the Beaufort Sea to the Sea of Japan. They are 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). There is no reliable estimate of the size of the Alaskan stock of spotted seals. The most current estimate for the eastern and central Bering Sea is 141,479 animals (95% CI 92,769–321,882). This number is derived from aerial surveys conducted by the National Marine Mammal Laboratory in 2007 from the United States Coast Guard icebreakers that provided greater access to the central and eastern Bering Sea pack ice (Ver Hoef et al. in review as cited in Allen and Angliss 2014). The NMFS conducted a status review of the spotted seal to determine if listing under the ESA was warranted, because of concerns about changing ice conditions and associated potential habitat loss (Boveng et al. 2009). Based on this status review, the NMFS did not list the Alaskan stock of spotted seals under the ESA. The Alaskan stock of spotted seals are not currently considered to be in danger of extinction or likely to become endangered in the foreseeable future (74 CFR 53683).

From late fall through spring, spotted seal habitat-use is closely associated with the distribution and characteristics of seasonal sea ice. The ice provides a dry platform away from land predators during the whelping, nursing, breeding, and molting periods (Boveng et al. 2009). In the Bering Sea, whelping typically occurs from late March to the end of April with most pups being born during early to mid-April to coincide with the average period of maximum extent and stability of the seasonal sea ice (Krylov et al. 1964; Tikhomirov 1964, 1966; Burns 2002; Burns et al. 1981). Adult spotted seals begin molting immediately after breeding (Tikhomirov 1964, Burns 2002). The herds break up when the usable sea ice disappears in early summer and spotted seals move toward ice-free coastal waters from Bristol Bay through western Alaska to the Chukchi and Beaufort seas. Unlike other ice seals, they use coastal haulouts for at least part of the summer.

When sea ice begins to form in the fall, spotted seals occupy the ice habitat, moving southwards to the Bering Sea (Lowry et al. 1998).

Savarese et al. (2010) reported between 59 and 125 spotted seals annually during surveys in the central Beaufort Sea between 2006−2008. During BPXA's OBC seismic survey in Foggy Island Bay, observers recorded a limited number of seal sightings (18), of which one confirmed a spotted seal (Aerts et al. 2008).

4.2.3. Ringed Seal (Phoca hispida)

Ringed seals (Phoca hispida) have a circumpolar distribution which includes year-round residency in the Bering, Chukchi, and Beaufort seas off the coast of western and northern Alaska (Frost and Lowry 1981; King 1983). There is currently no complete population estimate available for the entire Alaskan stock (Allen and Angliss 2014). Historic ringed seal population estimates in the BCB area ranged from 1-1.5 million (Frost 1985). Frost and Lowry (1984) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter, indicating that half of the population moves into the Chukchi and Bering seas in winter. There is increasing concern about the future of the ringed seal due to receding ice conditions and potential habitat loss. The NMFS listed the Arctic stock of ringed seals as threatened under the ESA, effective 26 February 2013 (77 CFR 76706); critical habitat was proposed on 9 December 2014 (79 CFR 73010).

Like the other ice seals, ringed seals are closely associated with sea ice during breeding, pupping, and molting. 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). Satellite-tagging data revealed that ringed seals cover large distances between foraging areas and haulout sites during the open-water season (Kelly et al. 2010a; Herreman et al. 2012). The time spent on haulout sites is much shorter than the time spent foraging in open water. For example, in July, ringed seals spent 70% of the time in open water, increasing to ≥90% in August (Kelly et al. 2010a).

Ringed seals have routinely been observed during previous seismic surveys in this region and time period (Aerts et al. 2008; Funk et al. 2008; Savarese et al. 2010; Brandon et al. 2011), during monitoring from Northstar Island (Aerts and Richardson 2009, 2010) and during aerial surveys flown for bowhead whales (Clarke et al. 2011a). They are typically the most abundant seal species seen in the Beaufort Sea. Based on available data, ringed seals are likely to be the most abundant marine mammal species encountered in the area of the proposed activities. Despite being the most abundant seal species, the number of expected seal encounters during the proposed sonar survey is low. This is based on seal observation data from recent, similar shallow water seismic surveys in the central Beaufort Sea (Aerts et al. 2008; Hauser et al. 2008; HDR, Inc. 2012).

4.3. Uncommon or Extralimital Species

Minke whales, humpback whales, killer whales, narwhal, harbor porpoises, and ribbon seals could occur in the Beaufort Sea but are either uncommon or extralimital (**Table 3**). These species are not expected to be encountered during the proposed Liberty Unit sonar survey.

Minke whales are relatively common in the Bering and southern Chukchi seas and have recently also been sighted in the northeastern Chukchi Sea (Aerts et al. 2013, Clarke et al. 2013a, 2014). Minke whales were also observed during the 2014 ASAMM-Chukchi effort (Flt. 232, 4 September, 2014 and Flt. 234, 6 September, 2014):

http://www.afsc.noaa.gov/NMML/cetacean/bwasp/flights_2014.php

Humpback whales are uncommon in the Arctic Ocean. Subsistence hunters have identified humpback whales in low numbers around Barrow in the past and there have been several confirmed sightings of humpback whales in the northeastern Chukchi Sea in recent years but their occurrence is not regular or frequent (Hashagen et al. 2009; Aerts et al. 2013; Clarke et al. 2013a, 2014; Smultea et al. 2004). The first confirmed sighting of a humpback whale in the Beaufort Sea was recorded in August 2007 (Hashagen et al. 2009), when a cow and calf were observed 54 mi east of Point Barrow. One humpback whale was seen west of Barrow in summer 2012 during oceanographic surveys conducted by the oil industry (L. Aerts, LAMA Ecological, pers. comm. to J. Clarke, 12 April 2013 *in* Clarke et al. 2014). Humpback whales have been frequently encountered since 2009 in the southern Chukchi Sea (from the Bering Strait to 69°N) (Clarke et al. 2013b), which may be due to increased research in the area, population recovery from commercial whaling and/or responses to oceanographic changes (Clarke et al. 2014).

Killer whales are known to inhabit almost all coastal waters of Alaska, extending from southeast Alaska through the Aleutian Islands to the Bering and Chukchi seas (Allen and Angliss 2014). Killer whales have been seen infrequently in the Beaufort Sea (Leatherwood et al. 1986, Allen and Angliss 2014). Hunters from Barrow and biologists from the North Slope Borough report that a few killer whales are seen each year in the Point Barrow area George et al. (1994). One group of 13 killer whales, including two calves, was seen on 20 August, 2012 approximately 10 km northwest of Barrow (Clarke et al. 2013a).

Narwhal are common in the waters of northern Canada, west Greenland, and in the European Arctic, but rarely occur in the Beaufort Sea (COSEWIC 2004). Only a handful of sightings have occurred in Alaskan waters (Allen and Angliss 2014). George and Suydam (unpublished data) summarized eight observations of 11-12 individuals by Alaska Native hunters in the Chukchi and Beaufort seas between 1989 and 2008. No narwhal have been reported during the BWASP / ASAMM surveys conducted in the Beaufort Sea.

Harbor porpoise occur from Point Barrow along the western Alaskan coast, along the Aleutians and throughout southeast Alaska (Allen and Angliss 2014) but are considered extralimital in the Beaufort Sea. Industry-sponsored monitoring between 2006-2010 reported six sightings of 11

harbor porpoises in the Beaufort Sea, suggesting harbor porpoises are occurring more regularly in small numbers in both the Chukchi and Beaufort seas (Funk et al. 2011).

Ribbon seals are found in the North Pacific Ocean and parts of the Arctic Ocean, most often along the pack ice (Allen and Angliss 2014). Ribbon seals have been sighted in very low numbers in the northeastern Chukchi Sea (Aerts et al. 2013, Haley et al. 2010). No ribbon seals have been reported as part of the BWASP surveys conducted in the Beaufort Sea or during seismic survey program monitoring, although three animals were reported during a vessel-based marine mammal monitoring program near Prudhoe Bay in 2008 (Savarese et al. 2010).

5. TYPE OF INCIDENTAL HARASSMENT AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

Hilcorp seeks authorization for non-lethal incidental "level B harassment" of marine mammals pursuant to Section 101(a)(5)(D) of the MMPA during its proposed sonar survey in the Liberty Unit, Beaufort Sea, for the period July 1 through September 30, 2015. "Level B harassment" is defined under the MMPA as "*any act of pursuit, torment or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding or sheltering.*"

Disturbance of whales and seals from the proposed sonar activities described in Section 1 of this request can occur due to:

- Exposure to sonar sounds used for data acquisition;
- Physical presence of vessels in the area, i.e., close approach between marine mammals and vessels.

The response of whales and seals to sounds depends on many factors as described in Section 7 of this application. Disturbance reactions, such as avoidance, may occur among some whales and seals in proximity to the source vessels when these vessel are actively surveying. Sonar sounds may also mask natural sounds of importance to marine mammals. No serious injury to whales and seals is expected from exposure to sonar sounds or from collisions with vessels, given the nature of the activity in combination with the planned mitigation measures (see Section 11). The use of vessel sonar systems are not likely to have any additional impact on whales and seals, given the relatively high operating frequency, short pulse duration, low duty cycle, and brief (if any) behavioral response. No lethal injuries are expected.

In summary, Hilcorp seeks authorization of incidental non-lethal harassment of whales and seals from sounds generated during the permitted sonar survey activities.

6. NUMBER OF MARINE MAMMALS THAT MAY BE HARASSED

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [Section V], and the number of times such takings by each type of taking are likely to occur.

This section describes the methods used to estimate the numbers of marine mammals that might be affected during the proposed sonar survey activities in the Liberty Unit. Section 7 provides a summary of potential impacts from sonar sounds on marine mammals. Exposure to sounds that lead to a temporary reduction in hearing sensitivity or permanent hearing damage in marine mammals in close proximity to the source is defined as level A harassment under the MMPA. Anthropogenic sounds generated during surveys may also elicit behavioral responses in marine mammals; the reaction is defined as level B harassment under the MMPA. The current thresholds for the onset of "level A harassment" from pulsed sounds are 190 dB re 1 µPa (rms) for seals and 180 dB re 1 µPa (rms) for whales under NMFS' jurisdiction. The threshold for "Level B harassment" from pulsed sounds is 160 dB re 1 µPa (rms) for all marine mammals (NMFS 2005). More information regarding marine mammal responses to pulsed sounds has become available since these criteria were established (e.g., Southall et al. 2007) and updated acoustic criteria are therefore being developed (NMFS 2013a). The new acoustic thresholds with potential for level A harassment will reflect species-specific differences in hearing sensitivity and duration of sound exposure. The new criteria for potential level B harassment will likely be based on dose-response curves specific to different marine mammal groups, acknowledging that marine mammals do not all react similarly to sound exposure and that not all individuals will respond when exposed to sounds.

Actual observations of impacts from sound exposure meeting the definition of "harassment" or "take" are rare, in part due to the difficulties associated with making and interpreting observations at sea. With that in mind sound exposures are being used as surrogates for "takes." The number of whales and seals potentially "taken" by sonar sounds requested in this IHA application are thus based on estimated number of exposures, realizing that exposures do not equal "take".

Number of possible exposures are based on estimated animal densities in the estimated area ensonified with pulsed sound levels of 160 dB re 1µPa (rms) or more during the course of the survey based on best available data. Species most likely to be encountered in the survey area in order of abundance from high to low are ringed seals, followed by bearded and spotted seals (see Section 4). Most bowhead whales occur farther offshore during July or August, although some animals have been observed in nearshore areas in the past few years (Clarke et al. 2013a, 2014 and 2014 ASAMM daily flight summaries). We don't expect to encounter bowhead whales within the project area during the survey period, and if we do, only in very low numbers. Gray whales and belugas could also occur in the project area; however the chance of encounters is also low. Although we don't expect to see any whale species that are rare or extralimital to the

Beaufort Sea, we have requested harassment authorization for a few animals to cover incidental occurrences.

Section 6.1 describes the approach used to estimate marine mammal densities representative for the area and season of operation. The estimated numbers of marine mammals potentially exposed and the requested authorization are summarized in Section 6.3.

6.1. Marine Mammal Density Estimates

During data acquisition, the source vessels of the proposed Liberty Unit shallow geohazard survey will cover an area of about 2.5 mi^2 in water depths ranging from 3 to 20 ft. Sonar data acquisition will be halted at the start of the Cross Island fall bowhead whale hunt, as agreed upon in the CAA. The total time span of the sonar survey period in the Foggy Island Bay area is estimated to be approximately 45 days. About 25% of downtime is included in this total, so the actual number of days that equipment are expected to be operating is estimated at 34, based on a continuous 24-hr operation.

As indicated in the species descriptions in Section 5 above, most whale species are migratory and therefore show a seasonal distribution, with different densities for the summer period (covering July and August) and the fall period (covering September and October). Seal species in the Beaufort Sea do not show a distinct seasonal distribution during the open water period between July and October. Data acquisition of the proposed sonar survey will only take place in summer (before start of Nuiqsut whaling), therefore only estimates of marine mammal densities for the summer are included in this IHA application. Whale and seal densities in the Beaufort Sea will further depend on the presence of sea ice. However, if ice cover within or close to the sonar survey area is more than approximately 10%, sonar survey activities may not start or be halted for safety reasons. Densities related to ice conditions are therefore not included in this IHA application.

Spatial differentiation is another important factor for marine mammal densities, both in latitudinal and longitudinal gradient. Taking into account the shallow water operations of the proposed sonar survey area and the associated area of influence, data from the nearshore zone of the Beaufort Sea is used for the calculation of densities, if available.

Density estimates are based on best available data. Because available data did not always cover the area of interest, estimates are subject to large temporal and spatial variation. Though correction factors for perception and availability bias have been calculated for certain coastal areas they were not always known for this study area. There is some uncertainty in the 2014 raw data and assumptions were used in the estimated number of exposures. To provide allowance for these uncertainties, maximum density estimates have been provided in addition to average density estimates.

6.1.1. Beaufort Sea Whale Densities

6.1.1.1. Belugas

The 1979–2011 BWASP aerial survey database, available from the NOAA website (http://www.afsc.noaa.gov/ NMML/software/bwasp-comida.php), contains a total of 62 belugas (31 sightings) in block 1, which covers the nearshore and offshore Prudhoe Bay area. Except for one solitary animal in 1992, all these belugas were seen in September or October; the months with most aerial survey effort. None of the sightings occurred south of 70°N, which is to be expected because belugas generally travel much farther north and therefore much further off shore (Moore and Clarke 1992). The summer effort in the 1979–2011 database is limited. We utilized the 2011–2013 data to be the best available data for calculating beluga summer densities (Clarke et al. 2012, 2013, 2014 and

http://www.afsc.noaa.gov/NMML/cetacean/bwasp/index.php).

To estimate the density of belugas in the Liberty Unit area, we used the 2011, 2012 and 2013 on-transect beluga sighting and effort data from the ASAMM surveys flown in July and August in the Beaufort Sea. The area most applicable to our survey was the area from 140W-154W and water depths of 0-20 m (Table 14 in Clarke et al. 2012, Table 13 in Clarke et al. 2013a, and Table 14 in Clarke et al. 2014). In addition, we used beluga sighting and effort data of the 2014 survey, as reported in the daily flight summaries on the NOAA website (n = 4 flights with data for block 1 between 19 July and 28 August 2014). It is important to note that the 2014 daily flight summaries posted on NOAA's website have not undergone post-season QAQC; introducing potential small unquantifiable error into this analysis. We intended to only select flights that covered block 1. However, in many cases the aerial surveys flown in block 1 also covered blocks 2, 3, 10 and 11, which were much farther from shore. Survey effort specific to block 1 was impossible to calculate based on the raw 2014 data. Therefore survey efforts from raw 2014 data include the sighting and effort data from blocks 2, 3, 10 and 11. We used the number of individuals counted on transect, and transect kilometers flown to calculate density estimates (**Table 4**).

To convert the number of individuals per line transect from (INDV/km) to a density per area (INDV/km^2), we multiplied the transect length by the average effective strip width (ESW; strictly speaking, the effective strip half-width) of 0.614 km modeled for belugas (n = 226 sightings); calculated from 2009-2011 aerial survey data flown utilizing Commander Aircraft (Ferguson and Clarke 2013). For example: 2012 Beluga data: [0.0010 (INDV/km) / {2*0.614 (km)}] = 0.0008 INDV/km^2.

For the purpose of calculating potential number of exposures to received sound levels of ≥160 dB re 1µPa, we used the minimum density from **Table 4** as the average estimate and the average density as the maximum estimate. The reason for this decision is that in 2014 only 13 of the 91 sightings occurred in block 1 and the majority of the sightings were much farther offshore, outside the zone of influence of the proposed project.

Table 4. Summary of beluga sighting and effort data from the 2011, 2012, 2013 and 2014 ASAMM aerial surveys flown in July and August in the Beaufort Sea. See text for more details on how we derived at the densities (INDV/km^2).

YEAR	EFFORT (IN km)	INDV	INDV/km	INDV/km^2
2011[a]	164	0	0	0
2012[a]	1001	1	0.0010	0.0008
2013[a]	1066	1	0.0009	0.0008
2014[b]	2499	91	0.0364	0.0296
			Average	*0.0078*
			Maximum	*0.0296*
			Minimum	*0.0008*

a – Published Quality Checked Survey Data
b – 2014 RAW Data, Not Quality Checked

6.1.1.2. Bowhead Whale

To estimate summer bowhead whale densities we used data from the 2011, 2012, 2013 and 2014 ASAMM aerial surveys flown in the Beaufort Sea (Clarke et al. 2012, 2013a and 2014; http://www.afsc.noaa.gov/NMML/cetacean/bwasp/index.php). The 1979–2011 ASAMM database contains only one on-transect bowhead whale sighting during July and August (in 2011), likely due to the limited summer survey effort. In contrast, the published 2012, 2013 and 2014 surveys include more effort during the summer season and are thus considered to be the best available data for calculating bowhead whale summer densities (Clarke et al. 2012, 2013a, 2014; http://www.afsc.noaa.gov/NMML/cetacean/bwasp/index.php).

To estimate the density of bowhead whales in the Prudhoe Bay area, we used the 2011, 2012 and 2013 on-transect bowhead sighting and effort data from surveys flown in July and August in block 1 (Table 5 in Clarke et al. 2012, Table 4 in Clarke et al. 2013a and Table 5 in Clarke et al. 2014). In addition, we used the on-transect bowhead sighting and effort data of the 2014 survey, as reported in the daily flight summaries on the NOAA website(n = 4 flights with data for block 1 between 19 July and 28 August 2014). It is important to note that the 2014 daily flight summaries posted on NOAA's website have not undergone post-season QAQC; introducing potential small unquantifiable error into this analysis. We intended to only select flights that covered block 1. However, in many cases the aerial surveys flown in block 1 also covered blocks 2, 3, 10 and 11, which were much farther from shore. Survey effort specific to block 1 was impossible to calculate based on the raw 2014 data. Therefore survey efforts from raw 2014 data include the sighting and effort data from blocks 2, 3, 10 and 11. We used the number of individuals counted on transect, and transect kilometers flown to calculate density estimates (**Table 5**).

To convert the number of individuals per line transect from (INDV/km) to a density per area (INDV/km^2), we multiplied the transect length by the average effective strip width (ESW; strictly speaking, the effective strip half-width) of 1.15 km modeled for bowhead whales (n = 78

sightings); calculated from 2009-2011 aerial survey data flown utilizing Commander Aircraft (Ferguson and Clarke 2013).

For the purpose of calculating potential number of exposures to received sound levels of ≥160 dB re 1µPa, we used the maximum density from **Table 5** to derive at a maximum estimate, we used the average density as the best estimate. Because the majority of the 2014 bowhead sightings in Block 1 occurred in close proximity to the zone of influence of the proposed project, we considered this approach reasonable.

Table 5. Summary of bowhead sighting and effort data from the 2011, 2012, 2013 and 2014 ASAMM aerial surveys flown in July and August in the Beaufort Sea. See text for more details on how we derived at the densities (INDV/km^2).

YEAR	EFFORT (IN km)	INDV	INDV/km	INDV/km^2
2011[a]	164	2	0.0122	0.0053
2012[a]	1001	0	0	0
2013[a]	1066	49	0.0460	0.0200
2014[b]	2499	57	0.0228	0.0099
			Average	*0.0088*
			Maximum	*0.0200*
			Minimum	*0.0053*

a – Published Quality Checked Survey Data
b – 2014 RAW Data, Not Quality Checked

6.1.1.3. Other whale species

No densities have been estimated for gray whales and for whale species that are rare or extralimital to the Beaufort Sea (humpback whale, minke whale, killer whale, harbor porpoise, narwhal; see **Table 3**), because sightings of this animals have been very infrequent. Gray whales may be encountered in small numbers throughout the summer and fall, especially in the nearshore areas. Small numbers of harbor porpoises may be encountered as well. During an aerial survey offshore of Oliktok Point in 2008, approximately 40 mi (65 km) west of the proposed survey area, two harbor porpoises were sighted offshore of the barrier islands, one on 25 August and the other on 10 September (Hauser et al. 2008). The first confirmed sighting of a humpback whale with calf was documented on 1 August 2007, about 54 miles (87 km) east of Point Barrow (Hashagen et al. 2009), so an occasional sighting could occur but is very unlikely. For the purpose of this IHA request, small numbers have been included in the requested "take" authorization to cover incidental occurrences of any of these species during the proposed survey (see Section 6.3).

6.1.2. Beaufort Sea Seal Densities

Ice seals of the Beaufort Sea are mostly associated with sea ice and most census methods count seals when they are hauled out on the ice. To account for the proportion of animals present but

not hauled out (availability bias) or seals present on the ice but missed (detection bias), a correction factor should be applied to the "raw" counts. This correction factor is dependent on the behavior of each species. To estimate what proportion of ringed seals were generally visible resting on the sea ice, radio tags were placed on seals during spring 1999-2003 (Kelly et al. 2006). The probability that seals were visible, derived from the satellite data, was applied to seal abundance data from past aerial surveys and indicated that the proportion of seals visible varied from less than 0.40 to more than 0.75 between survey years. The environmental factors that are important in explaining the availability of seals to be counted were found to be time of day, date, wind speed, air temperature, and days from snow melt (Kelly et al. 2006). Besides the uncertainty in the correction factor, using counts of basking seals from spring surveys to predict seal abundance in the open-water period is further complicated by the fact that seal movements differ substantially between these two seasons. Data from nine ringed seals that were tracked from one subnivean period (early winter through mid-May or early June) to the next showed that ringed seals covered large distances during the open water foraging period (Kelly et al. 2010b). Ringed seals tagged in 2011 close to Barrow also show long distance travel during the open water season (Herreman et al. 2012).

To estimate densities for ringed, bearded and spotted seals, we used data collected during four shallow water OBC seismic surveys in the Beaufort Sea (Harris et al. 2001, Aerts et al. 2008, Hauser et al. 2008, HDR 2012). Habitat and survey specifics are very similar to the proposed survey, therefore these data were considered to be more representative than basking seal densities from spring aerial survey data (e.g., Moulton et al. 2002; Frost et al. 2002, 2004).

Because survey effort in kilometers was only reported for one of the surveys, we used sighting rate (INDV/hr.) for calculating potential seal exposures. No distinction is made in seal density between summer and autumn season. Also, no correction factors have been applied to the reported seal sighting rates.

6.1.2.1. All seal species

During the 1996 OBC survey, 92% of all seal species identified were ringed seals, 7% bearded seals and 1% spotted seals (Harris et al. 2001). This 1996 survey occurred in two habitats, one about 19 mile east of Prudhoe Bay near the McClure Islands, mainly inshore of the barrier islands in water depths of 10 to 26 ft. and the other 6 to 30 mi northwest of Prudhoe Bay, about 0 to 8 mile offshore of the barrier islands in water depths of 10 to 56 ft. (Harris et al. 2001). In 2008, two OBC seismic surveys occurred in the Beaufort Sea, one in Foggy Island Bay (Aerts et al. 2008), and the other at Oliktok Point, more than 30 mi west of Prudhoe Bay (Hauser et al. 2008). In 2012, an OBC survey was done in Simpson Lagoon, bordering the area surveyed in 2008 at Oliktok Point (HDR 2012). Based on the number of identified individuals the ratio of ringed, bearded, and spotted seal was 75%, 8%, and 17%, respectively in Foggy Island Bay (Aerts et al. 2008), 22%, 39%, and 39%, respectively at Oliktok Point (Hauser et al. 2008), and 62%, 15%, and 23%, respectively in Simpson Lagoon (HDR 2012). Because it is often difficult to identify seals to species, a large proportion of seal sightings were unidentified in all four OBC surveys described

here. The total seal sighting rate was therefore used to calculate densities for each species, using the average ratio over all four surveys for ringed, bearded and spotted seals, i.e., 63% ringed, 17% bearded, and 20% spotted seals.

During the 1996 OBC survey (Harris et al. 2001) the sighting rate for all seals during periods when equipment was not operating was 0.630 INDV/hr. The sighting rate during non-seismic periods was 0.046 INDV/hr. for the survey in Foggy Island Bay (Aerts et al. 2008). The OBC survey that took place at Oliktok Point recorded 0.0674 INDV/hr. when equipment was not operating (Hauser et al. 2008), and the maximum sighting rate during the Simpson Lagoon OBC seismic survey was 0.030 INDV/hr. (HDR 2012).

The average seal sighting rate, based on these four surveys, was 0.193 INDV/hr. The maximum was 0.63 INDV/hr. and the minimum 0.030 IND/hr. Using the proportion of ringed, bearded, and spotted seals as mentioned above, we estimated the average and maximum sighting rates (INDV/hr.) for each of the three seal species (**Table 6**).

Table 6. Estimated summer densities of whales and sighting rates of seals (average and maximum) for the proposed North Prudhoe Bay survey. Densities are provided in number of individuals per km^2 (IND/km^2), sighting rates in number of individuals per hour (INDV/hr.). No densities or sighting rates were estimated for extralimital species.

SPECIES	SUMMER DENSITIES (INDV/km^2) AVERAGE	MAXIMUM
Bowhead whale	0.0088	0.0200
Beluga	0.0008	0.0078
	SUMMER SIGHTING RATES (INDV/hr.) AVERAGE	MAXIMUM
Ringed seal	0.122	0.397
Bearded seal	0.033	0.107
Spotted seal	0.039	0.126

6.2. Safety and Disturbance Zone Distances

The Liberty Unit shallow geohazard survey will incorporate the use of Multi-beam and Sidescan sonar and ice gouge and strudel scour surveys. The ice gouge and strudel scour surveys will not involve the use of airguns but rather involve the use of smaller, higher-frequency sound sources, such as multibeam echosounders and sub-bottom profilers.

Sidescan sonar utilizes a sonar device called a “tow-fish” to record images of the seafloor. The tow-fish is towed behind the boat, and emits regular soundwaves from transducers on the side of the tow-fish, hence the name sidescan. These pulses are reflected back to the tow-fish when they encounter an obstruction in their path.

Multibeam sonar is a geophysical survey technique that uses a transducer that is located underneath the boat. Similarly to the sidescan, it emits regular soundwaves from the transducer, which are reflected back when they encounter an obstruction in their path. However instead of measuring the intensity of the returned reflection, it measures the time it takes for the pulse to travel to the obstruction and return.

Sub-bottom profiling is a technique that utilized a piece of equipment referred to as a "boomer". The device is either mounted on the boat or towed behind. It uses sound pulses to penetrate the seafloor and make an image of the geological layers beneath it. As the sound waves travel through the ground, they are reflected back when a change in the geology occurs.

Marine magnetometry does not use soundwaves, but detects variations in the Earth's total magnetic field. The variations in the magnetic field are caused by the presence of ferrous (iron) material on or under the seafloor. Marine magnetic surveying has become a standard technique for mapping the location of ferrous material on the seabed.

The operating frequencies of the multibeam, single-beam, and sidescan sonar equipment in this survey are above the hearing range of all marine mammals and therefore not included in **Table 7**. Estimated distances to sound pressure levels of 190, 180, and 160 dB re 1 µPa, generated by the proposed sub-bottom equipment is provided in **Table 7**. Sounds generated by the sub-bottom profiler are within the hearing range of all marine mammal species occurring in the area. Review of current information for similar equipment in the Arctic resulted in estimating the distance to 160 dB re 1 µPa (rms) at 30m (Warner & McCrodan 2011). The mitigation radius of the proposed sub-bottom profiler is provided in (**Table 8**).

Table 7. Distances (in meters) to four received Sound Pressure Levels (SPLs) [In dB re 1 µPa (rms)] from existing measurements of geophysical equipment, similar to those proposed for this survey. Measurements were conducted in water depths of about 100ft. (~35m). Source: Warner & McCrodan 2011.

EQUIPMENT	DISTANCE (IN METERS)				COMMENT
	190 dB	180dB	160dB	120dB	
Sub-bottom profiler (Directional Beam)	< 30	< 30	30	450	Within hearing range of all marine mammal species

Table 8. Distances (in meters) to be used for mitigation purposes for the proposed 2015 Liberty Unit Shallow Geohazard survey.

EQUIPMENT	DISTANCE (IN METERS)
Sub-bottom Profiler	50

6.3. Number of marine mammals potentially affected

The current threshold for the onset of potential "level B harassment" from pulsed sounds for marine mammals under NMFS' jurisdiction is 160 dB re 1 µPa (rms) (NMFS 2005). The radii associated with received sound levels of 160 dB re 1 µPa (rms) or higher were therefore used to calculate the number of potential marine mammal exposures to sonar sounds for this IHA application. The distances to received levels of 180 dB and 190 dB re 1 µPa (rms) are mainly relevant as safety radii to avoid level A harassment of marine mammals through implementation of shut down and power down measures (see Section 11 for a summary of the mitigation measures).

The potential number of marine mammals that might be exposed to the 160 dB re 1 µPa (rms) sound pressure level was calculated differently for whales and seals as described in the sections below. **Table 9** summarizes the number of potential marine mammal exposures to pulsed sound levels of ≥160 dB re 1 µPa (rms) during the proposed sonar data acquisition and specifies the number for which authorization is requested. The sounds generated by the multibeam echosounder, sidescan sonar, and sub-bottom profiler are either outside the hearing range of marine mammals, or not strong enough to propagate at distances far enough to expect marine mammals to be present and to respond in manner that would constitute a "take" under the MMPA.

6.3.1 Number of Whales Potentially Exposed to ≥160 dB

The potential number of bowhead whales and belugas that might be exposed to the 160 dB re 1 µPa (rms) sound pressure level was calculated by multiplying:

- the expected bowhead and beluga density as provided in **Table 6**;
- the total 160 dB re 1 µPa (rms) ensonified area in a single hour by the vessel travelling at 3 knots; and
- the estimated number of hours that the source vessels are operating.

The calculated area (0.0079 km^2) expected to be ensonified is determined based on the maximum distance to the 160 dB re 1 µPa (rms) sound pressure level for the Sub-bottom profiler (**Table 7**), which is 0.05 km.

The estimated number of 24-hr days of sonar operations was determined by assuming a 25% downtime during the planned 45-day time span of the sonar survey period. Downtime is related to weather, equipment maintenance, mitigation implementation, and other circumstances. The total number of full 24-hr days that data acquisition is expected to occur is ~34 days or 816 hours.

The total 160 dB re 1 µPa (rms) ensonified area in a single hour by the vessel is calculated as 0.556 km^2 / hr.

Average and maximum estimates of the number of bowhead whales and belugas potentially exposed to sound pressure levels of 160 dB re 1µPa (rms) or more are summarized in **Table 9**.

Species such as gray whale, narwhal, killer whale and harbor porpoise are not expected to be encountered but might be present in very low numbers; the maximum expected numbers of exposures for these species (**Table 9**) are based on the likelihood of incidental occurrences.

The average and maximum number of bowhead whales potentially exposed to sonar sound levels of 160 dB re 1µPa (rms) or more is estimated at 4 and 9 respectively. The limited number of exposures is due to the low estimated density of bowheads in Foggy Island Bay during July and August, the short duration of the survey, and the small acoustic footprint. For the requested authorization, the maximum number was increased by three to account for unexpected bowhead occurrences.

The average and maximum number of potential beluga exposures to 160 dB is < 1. Belugas are known to show aggregate behavior and can occur in large numbers in nearshore zones, as evidenced by the sighting from Endicott in August 2013. For the unlikely event that a group of belugas appears within the 160 dB isopleth during the Liberty Unit shallow geohazard survey, the number of 75 was added to the requested authorization. Chance encounters with small numbers of other whale species are possible, but exposures to 160 dB or more are very unlikely for these species.

These estimated exposures do not take into account the mitigation measures that will be implemented, such as marine mammal observers watching for animals, shutdowns or power downs of the equipment when marine mammals are seen within defined ranges. These measures will further reduce the number of exposures and expected short-term reactions, and minimize any effects on hearing sensitivity.

6.3.2 Number of Seals Potentially Exposed

The estimated number of seals that might be exposed to pulsed sounds of 160 dB re 1 µPa (rms) is calculated by multiplying:

- the expected species specific sighting rate as provided in **Table 6**; and
- the total number of hours that each source vessel will be operating during the data acquisition period.

The estimated number of hours that the sonar equipment will operate was determined by assuming a 25% downtime during a 45-day survey period, which is a total of 816 hours (34 days of 24 hour operations).

Table 9. Average and maximum estimated number of whales and seals potentially exposed to sound levels of 160 dB re 1µPa (rms) or more during the Liberty Unit sonar survey. The number of animals for which authorization is requested is specified in a separate column.

SPECIES	NR OF IND POTENTIALLY EXPOSED TO ≥160 DB		REQUESTED AUTHORIZATION	ESTIMATED POPULATION SIZE	TAKE % OF POPULATION
	AVG	MAX			
Bowhead whale	4	9	12	12,631	0.095
Beluga	<1	<1	(75)*	39,258	0.191
Gray whale	0	3	3	19,126	0.016
Killer whale	0	3	3	Rare/Extralimital	
Harbor porpoise	0	3	3	Rare/Extralimital	
Humpback whale	0	1	1	Rare/Extralimital	
Minke whale	0	1	1	Rare/Extralimital	
Ringed seal	100	324	350	300,000	0.117
Bearded seal	27	87	100	155,000	0.064
Spotted seal	32	103	120	141,479	0.085
Ribbon seal	0	3	3	61,000	0.005

* *A number of 75 is added to the requested authorization for the unlikely event that a group of belugas appears within the 160 dB isopleth during the sonar survey*

Hilcorp's requested authorization for harassment of seals covers the maximum number of animals potentially exposed, based on the sighting numbers from the three most recent OBC seismic surveys. Also, seals are not likely to react to sonar sounds unless the received levels are 170 dB re 1 µPa (rms), and many of those exposed to 170 dB will still not react overtly (Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005). It is therefore probable that at the received level of 160 dB re 1 µPa (rms) only a small percentage of seals would actually be disturbed. Any disturbance to seals is expected to be a short-term response without any negative consequences for the individuals or their populations.

7. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammals.

This section summarizes the potential impacts on marine mammals from the proposed sonar surveys. Several factors should be considered when determining the potential impact from sound exposure, such as what species will be exposed, for how long, to what frequencies, at what levels, and how do these parameters compare with an animal's hearing ability. We don't have the answers to all of these factors and, consequently, we know little about the incidence and nature of long-term noise effects in most marine mammals, making it difficult to estimate probable risks from anthropogenic sources for wild marine mammal populations. However,

there is some knowledge about marine mammal responses to anthropogenic underwater sounds, which we summarized below based on available literature.

7.1. Hearing Impairment and Non-Auditory Injury

Permanent or temporary hearing impairment or threshold shifts could occur when marine mammals are exposed to very strong sounds or to less strong sounds for a prolonged period. Close proximity to sound has the potential for permanent or temporary threshold shifts (PTS or TTS). Current policy regarding exposure of marine mammals to high-level sounds is that whales and seals should not be exposed to impulsive sounds ~180 and ~190 dB re 1 IJPa (rms), respectively (NMFS 2000). Those criteria have been used in defining the safety (shutdown) radii planned for the proposed shallow geohazard survey, but were established without actual data on the minimum received levels of sounds necessary to cause temporary auditory impairment in marine mammals. Based on an extensive review and syntheses of newly available data on possible TTS and PTS onset in marine mammals from pulsed sounds (Southall et al. 2007), it was suggested that threshold criteria for TTS and PTS should be based on peak sound pressure levels or cumulative sound exposure levels. Efforts are currently underway to revise the existing criteria taking into account the most recent scientific data on TTS (NMFS 2013a; NOAA 2013).

In theory, hearing impairment and non-auditory physical effects (e.g., stress, neurological effects, bubble formation, and other types of organ or tissue damage) might occur in marine mammals exposed to strong, pulsed underwater sounds. However, the limited data available from captive marine mammals do not provide definitive evidence that any of these effects occur even for marine mammals in close proximity to sound sources. Most baleen whales, some toothed whales (including belugas), and some seals will present behavioral avoidance of source vessels operating survey equipment. In addition, the planned monitoring and mitigation measures include shutdowns of equipment should animals enter designated "safety radii." Given the brief duration of exposure of any marine mammal in combination with the proposed monitoring and mitigation measures, auditory impairment or other non-auditory physical effects are unlikely to occur during the present project. The following subsections provide more detail about current knowledge of TTS, PTS, and non-auditory physical effects from pulsed sounds.

Permanent and Temporary Threshold Shift (PTS, TTS)

Noise induced hearing loss occurs when sensitive structures in the inner ear are damaged, which can happen following exposure to harmful noise, i.e., very loud impulsive sounds or very loud continuous sounds over a long duration. These sensitive structures, called cochlear hair cells, are small sensory cells that convert sound energy into electrical signals that travel to the brain. Once damaged, hair cells cannot grow back. PTS occurs when exposure to impulsive or continuous noise results in damage of hair cells and thus in permanent hearing loss. TTS or temporary hearing loss occurs following sound exposures less severe than those that cause PTS.

No direct information is available about what sound characteristics have the potential to elicit onset of PTS in marine mammals. Instead, the potential for PTS has been derived from studies

measuring the onset of TTS. Most of these studies were conducted with captive toothed whales, such as bottlenose dolphins and beluga whales (see review in Southall et al. 2007). Both species are mid-frequency cetaceans. Only limited information on TTS exists for high-frequency cetaceans (e.g., Lucke et al. 2008; Popov et al. 2011) and none for low-frequency cetaceans (baleen whales). To derive criteria for auditory injury, Southall et al. (2007) used the TTS data available for mid-frequency cetaceans as a surrogate for the low- and high-frequency cetaceans, assuming that all groups have similar auditory mechanisms. Animals do not perceive equally well at all frequencies within their functional hearing range. Sound sources that have their primary spectral components at frequencies that animals can only perceive at high received sound levels, if at all, are less likely to affect the animal. Test sounds used in TTS experiments consist of frequencies that fall well within the functional hearing range of the animals, though not necessarily always within their best hearing sensitivity. Most TTS experiments in which toothed whales, porpoises, and seals were exposed to sound signals used non-pulse tones of frequencies from about 2-115 kHz. Toothed whales exposed to such tones of various duration, showed brief, mild TTS at received sound pressure levels (SPL) of 190 - 204 dB re 1 µPa (Schlundt et al. 2000; Finneran et al. 2005, Finneran and Schlundt 2007). Harbor porpoises seemed to be more susceptible to TTS than harbor seals when exposed to octave-band white noise centered around 4 kHz for 60 minutes (Kastelein et al. 2012). TTS studies with baleen whales do not exist, thus levels or properties of sound that are required to induce TTS in baleen whales are unknown.

7.2. Potential effects of sonar systems

The proposed Liberty Unit sonar survey will use acoustic equipment such as a multibeam echosounder, sidescan sonar, and sub-bottom profiler to obtain accurate information regarding bathymetry and objects on the seafloor. Sounds produced by these instruments have the potential to cause hearing impairment, masking, and behavioral responses in marine mammals. The extent to which marine mammals may be impacted depends on several factors. There are two main questions that should be considered to assess the impact on marine mammals from these sound sources:

1. Is the sound generated by these instruments within the hearing range of the marine mammal species occurring in the area?
2. If the sound is within the hearing range, what are the propagation characteristics, and at what distances does the generated sound reach levels at which hearing impairment or behavioral responses could occur?

As discussed in previous sections of this request, marine mammal species belonging to three "hearing classes" (from Southall et al. 2007) could occur in the project area:

1. Low frequency cetaceans, believed to hear at frequencies between about 7 Hz and 30 kHz, with the upper level based on new information from NOAA 2013. Bowhead and gray whales belong to this hearing class. Bowhead whales generally occur well offshore

from the project area and do not occur in the Beaufort Sea in large numbers until mid-August or later. Gray whales are not commonly sighted in the Beaufort Sea.

2. Mid-frequency cetaceans, believed to hear at frequencies between about 150Hz to 160 kHz. Most toothed whale species belong to this hearing class, such as the beluga whale. Although the beluga whale generally travels far offshore, they occasionally occur in coastal waters and therefore could be present in the project area.
3. Phocid pinnipeds, believed to hear at frequencies between about 75 Hz and 100 kHz (NOAA 2013). All three ice seal species that are expected to occur in the project area belong to this hearing class.

Taking into account the auditory bandwidth of the marine mammal species listed above, the multibeam echosounder and the sidescan sonar do not produce frequencies within the hearing range of marine mammals that could occur in the project area. Exposure to sounds generated by these instruments therefore does not present a risk of potential physiological damage, hearing impairment, and behavioral responses.

Sub-bottom profilers will be audible to all three hearing classes of marine mammals that occur in the project area. Distances to sound levels of 160 dB re 1µPa (rms) that could result in behavioral responses, ranged from 1 to 30 m. It is unlikely that an animal would be exposed for an extended time to a signal strong enough for PTS to occur, unless the animal is present within the beam under the vessel and swimming with the same speed and direction. However, the response, if it occurs at all, is expected to be short term and without any biological consequences to the individual animal or population.

7.2.1 Masking

It is unlikely that sounds produced by the sonar equipment described here will meaningfully mask marine mammal communications given its directionality, and the brief period when an individual mammal is likely to be within its beam. In the case of bowhead whales, the frequencies of the sonar signals will not overlap with the predominant low frequencies in their calls, further reducing masking potential for bowheads.

7.2.2 Stranding and Mortality

Some stranding events of mid-frequency cetaceans were attributed to the presence of sonar surveys in the area (e.g., Southall et al. 2006). Recently, an independent scientific review panel concluded that the mass stranding of approximately 100 melon-headed whales in northwest Madagascar in 2008 was primarily triggered by a multibeam echosounder system (Southall et al. 2013), acknowledging that it was difficult to find evidence showing a direct cause-effect relationships. Both the multibeam echosounder and the sidescan sonar equipment proposed in this survey will operate at much higher frequencies, outside the hearing range of any marine mammal. Considering the acoustic specifics of these instruments, the shallow water

environment, the unlikely presence of toothed whales in the area, and planned mitigation measures, no marine mammal stranding or mortality are expected.

8. ANTICIPATED IMPACT ON SUBSISTENCE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

Subsistence hunting and fishing are essential for Alaska residents to maintain social organization and household economics, particularly in rural coastal villages (Wolfe and Walker 1987). Resources obtained through subsistence hunting and fishing are highly valued commodities fundamental to the customs and traditions of the Inupiat culture, including artistic expression, religion and family life. Subsistence harvesting provides important sources of nutrition in almost all Arctic rural communities and is a vital part of their livelihood.

Hilcorp does not expect that the proposed project activities will adversely affect subsistence hunting. Mitigation measures will be implemented to minimize or completely avoid any adverse effects on the availability of subsistence resources. Additionally, avoidance guidelines and mitigation measures are developed in a formal agreement with the AEWC, individual community Whaling Captain's Associations, Hilcorp and other Industry Participants in the form of the Conflict Avoidance Agreement (CAA).

8.1. Subsistence Resources

Marine mammals are legally hunted in Alaskan waters by coastal Alaska Natives and represent between 60% and 80% of their total subsistence harvest. The species regularly harvested by subsistence hunters in and around the Beaufort Sea are bowhead and beluga whales, ringed, spotted, and bearded seals, and polar bears. The latter is not discussed in this section, as polar bears do not fall under the jurisdiction of NMFS. The importance of each of the subsistence species varies among the communities and is mainly based on availability and season.

The communities closest to the project area are, from west to east, the villages of Barrow, Nuiqsut and Kaktovik. Barrow is located >200 mi west from the survey area. It is the largest community on the Alaska's Beaufort Sea coast. Important marine subsistence resources for Barrow include bowhead and beluga whales, ice seals, polar bears, and walrus. Nuiqsut is located near the mouth of the Colville River, about 55 mi southwest of the project area. Most important marine subsistence resource for Nuiqsut is the bowhead whale, and to a lesser extent belugas, polar bears, and seals. Nuiqsut hunters use Cross Island, (~20 mi northwest of the project area) as a base to hunt for bowhead whales during the fall migration and have historically hunted bowhead whales as far east as Flaxman Island. Kaktovik is located on Barter Island, about 120 mi east of the project area. Major marine subsistence resources include bowhead and beluga whales, seals, and polar bears.

8.1.1. Bowhead Whale

The bowhead whale is a critical subsistence and cultural resource for the North Slope communities of Barrow, Nuiqsut, and Kaktovik (**Table 10**). The level of allowable harvest is determined under a quota system in compliance with the International Whaling Commission (IWC 1980; Gambell 1982). The quota is based on the nutritional and cultural needs of Alaskan Natives as well as on estimates of the size and growth of the Bering-Chukchi-Beaufort seas stock of bowhead whales (Donovan 1982; Braund 1992). The AEWC allots the number of bowhead whales that each community is permitted to harvest. Contemporary whaling in Kaktovik dates from 1964 and in Nuiqsut from 1973 (EDAW/AECOM 2007; Galginaitis and Koski 2002). The number of boats used or owned in 2011 by the subsistence whaling crew of the villages of Kaktovik, Nuiqsut, and Barrow was 8, 12, and 40, respectively. These numbers presumably change from year to year.

Bowhead harvesting in Barrow occurs both during the spring (April-May) and fall (September-October) when the whales migrate relatively close to shore (ADNR 2009). During spring bowheads migrate through open ice leads close to shore. The hunt takes place from the ice using umiaks (bearded seal skin boats). During the fall, whaling is shore-based and boats may travel up to 30 mi a day (EDAW/AECOM 2007). In Barrow, most whales were historically taken during spring whaling. More recently, however, the efficiency of the spring harvest appeared to be lower than the autumn harvest due to ice and weather conditions as well as struck whales escaping under the ice (Suydam et al. 2010). In the past few years the bowhead fall hunt has become increasingly important.

Nuiqsut and Kaktovik hunters harvest bowhead whales only during the fall. The bowhead spring migration in the Beaufort Sea occurs too far from shore for hunting because ice leads do not open up nearshore (ADNR 2009). In Nuiqsut, whaling takes place from early September through mid-to-late September as the whales migrate west (EDAW/AECOM 2007). Three to five whaling crews base themselves at Cross Island, a barrier island approximately 20 mi northwest of the Liberty Unit shallow geohazard survey area. Nuiqsut whalers harvest an average of 2 bowheads each year (Table 10). Whaling from Kaktovik also occurs in the fall, primarily from late August through late September or early October (EDAW/AECOM 2007). Kaktovik whalers hunt from the Okpilak and Hulahula rivers east to Tapkaurak Point (ADNR 2009). Whaling activities are staged from the community rather than remote camps; most whaling takes place within 12 mi of the community (ADNR 2009). Kaktovik whalers harvest an average of 2–3 bowhead whales each year (**Table 10**).

Table 10. Average number (standard deviation) of bowhead whales landed in Barrow, Nuiqsut, and Kaktovik between 1974-1977 and 1978-2011 (the quota was instituted in 1978). Source: Suydam and George 2012

VILLAGE	1974-1977 AVERAGE/YEAR	1978-2011 AVERAGE/YEAR
Barrow	15.5 (7.05)	15.5 (8.23)
Nuiqsut	0	2.0 (1.22)
Kaktovik	1.5 (1.0)	2.5 (1.0)

8.1.2. Beluga

The harvest of belugas is managed cooperatively through an agreement between NMFS and the Alaska Beluga Whale Committee (ABWC). From 2005-2009, between 5 and 48 belugas were harvested annually from the Beaufort Sea stock (Allen and Angliss 2014); with a mean annual take of 25.8 animals. Both Nuiqsut and Kaktovik harvest few belugas, mostly opportunistically during the fall bowhead hunt.

8.1.3. Seals

Seals represent an important subsistence resource for the North Slope communities. Harvest of bearded seals usually takes place during the spring and summer open water season from Barrow (EDAW/AECOM 2007) with only a few animals taken by hunters from Kaktovik or Nuiqsut. Seals are also taken during the ice-covered season, with peak hunting occurring in February (ADNR 2009). In 2003, Barrow-based hunters harvested 776 bearded seals, 413 ringed seals and 12 spotted seals (ADNR 2009). Nuiqsut hunters harvest seals in an area from Cape Halkett to Foggy Island Bay. For the period 2000-2001, Nuiqsut hunters harvested one bearded seal and 25 ringed seals (ADNR 2009). Kaktovik hunters also hunt seals year-round. In 2002-2003, hunters harvested 8 bearded seals and 17 ringed seals.

8.2. Anticipated Impact

The proposed shallow geohazard survey will take place between 1 July and 30 September, with data acquisition occurring in July and August. The project area is located >200 mi east from Barrow, approximately 55 mi northeast from Nuiqsut (20 mi southeast of Cross Island), and 120 mi west from Kaktovik. Potential impact on the subsistence hunt from the planned activities is expected mainly from sounds generated by sonar equipment. Due to the timing of the project and the distance from the surrounding communities, there will be no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga and subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July-September in the Beaufort Sea). The community of Nuiqsut may begin fall whaling activities in late August to early September from Cross Island (northwest of the survey area). As part of the planned mitigation measures, Hilcorp will complete all operations at a date

agreed upon by the Nuiqsut whaling captains as captured in the CAA. No or little impact on the fall bowhead hunt from the proposed activities is therefore expected to occur.

Hilcorp will participate in Conflict Avoidance Agreement (CAA) discussions to meet the requirements for a Plan of Cooperation as specified in 50 CFR 216.104 Article 12 of the MMPA. The CAA will identify what measures have been or will be taken to minimize adverse impacts of the planned activities on subsistence harvesting (see Section 12 for more details). Hilcorp will meet with the AEWC and communities' Whaling Captains' Associations as part of the CAA development, to establish avoidance guidelines and other mitigation measures to be followed where the proposed activities may have an impact on subsistence.

9. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

There is no anticipated impact on marine mammal habitat from the proposed activities; the equipment deployed during the Liberty shallow geohazard survey will not come in contact with the seafloor and are not a source of air or water pollution. The primary potential impact associated with the proposed activity will be elevated sound levels and their associated direct effects on marine mammals rather than any specific impact to habitat (see discussion in Section 6 and 7). As described in Section 7, avoidance reactions by whales and seals, if they occur, will be of short duration and limited to a relatively small area around the source vessel.

With respect to the prey species of seals and some whales, the sonar equipment used in the proposed surveys are not predicted to impact fish (Personal communication R. Hander (USFWS), November 2014). The only designated Essential Fish Habitat (EFH) species that may occur in the vicinity of the planned project activities are adult salmon, and their presence in the Beaufort Sea is limited although possibly increasing (George et al. 2007, Bacon et al. 2009, Fechhelm et al. 2013). While there is limited data on the impacts of sonar on food resources of whales and seals, there is no information to suggest that any potential impacts will affect marine mammal populations.

10.ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

There is no anticipated impact on marine mammal habitat from the proposed activities; the equipment deployed during the Liberty shallow geohazard survey will not come in contact with the seafloor and are not a source of air or water pollution.

11. MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

The introduction of sonar sounds into the marine environment is the main source of potential impacts on marine mammals and is the focus of this request. As discussed in Section 7, exposure to sonar sounds in close proximity to the source may result in different effects to marine mammals, such as TTS or PTS or behavioral changes. The mitigation measures described in this section, implemented to reduce any potential impact on marine mammals, are based on a combination of requirements set forth by NMFS. The mitigation measures can be divided into two main groups:

1. General mitigation measures that apply to all vessels involved in the survey (Section 11.1);
2. Specific mitigation measures that apply to source vessels operating sonar (Section 11.2).

The primary purpose of the specific measures is to detect marine mammals within, or about to enter designated safety zones and to initiate immediate shutdown or power down of the equipment. Protected Species Observers (PSOs) are an important component in implementing these mitigation measures. Section 11.3 provides information on the PSO observation protocol, communication procedures, and data recording.

11.1. General mitigation measures

These general mitigation measures apply to all vessels that are part of the Foggy Island Bay sonar survey. The source vessel will operate under an additional set of specific mitigation measures during operations as summarized in Section 11.2.

- To minimize collision risk with marine mammals, vessels shall not be operated at speeds that would make collisions likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of marine mammal collisions.
- Vessel operators shall check the waters immediately adjacent to a vessel to ensure that no marine mammals will be injured when the vessel's propellers (or screws) are engaged.
- Vessel operators shall avoid concentrations or groups of whales and vessels shall not be operated in a way that separates members of a group. In proximity of feeding whales or aggregations, vessel speed shall be less than 10 knots.
- When within 900 ft. (300 m) of whales vessel operators shall take every effort and precaution to avoid harassment of these animals by:
    - Reducing speed and steering around (groups of) whales if circumstances allow, but never cutting off a whale's travel path;
    - Avoiding multiple changes in direction and speed.
- Sightings of dead marine mammals will be reported immediately to the Hilcorp Wildlife Specialist. The Hilcorp Wildlife Specialist is responsible for ensuring reporting of the sightings according to the guidelines provided by NMFS.

11.2. Sonar Survey Mitigation Measures

Specific mitigation measures will be adopted during sonar operations according to NMFS guidelines, provided that doing so will not compromise operational safety requirements. The mitigation measures outlined below have been established by NMFS to prevent marine mammals from exposures to received sound pressure levels of 190 dB re 1µPa (rms) for seals and 180 dB re 1µPa (rms) for whales. The sounds generated by the multibeam echosounder and sidescan sonar are outside the hearing range of marine mammals. Sounds generated by the sub-bottom profiler are within the hearing range of all marine mammal species occurring in the area. The distance to 160 dB re 1 µPa (rms) is estimated at 30m (Warner & McCrodan 2011). The mitigation radius of the proposed sub-bottom profilers is provided in (**Table 8**).

Protected Species Observers (PSOs) on board of the source vessels play a key role in monitoring the safety zone and implementation of the mitigation measures. Their primary role is to monitor marine mammals near the sonar source vessel during all daylight operations and during any nighttime start-up of the sonar operations. Pre-season estimated distances to received sound levels of 190 and 180 dB, produced by the proposed equipment, has been determined based on existing SSV measurements (**Table 7**). PSOs will use the 50 m distance to monitor the safety zone during the entire project. When marine mammals are observed within, or about to enter, the designated safety zone, PSOs have the authority to call for immediate power down (or shutdown) of operations as required by the situation. A summary of the procedures associated

with each mitigation measure is provided below. The criteria are consistent with guidance by NMFS.

11.2.1. Shutdown Procedures

The operating equipment will be shutdown completely if a marine mammal approaches or enters the 50 m safety radius. Sonar activity will not resume until the marine mammal has cleared the safety radius.

11.2.2. Poor visibility conditions

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

- If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 50 m safety zone is not visible, the sonar equipment cannot resume from a full shut-down.
- If sonar equipment is operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions; on the assumption that marine mammals will be alerted by the sounds from the vessel and have moved away.
- Sonar equipment will not be operated during long transits when exploration activities are not occurring, or if visibility conditions impede safe vessel operations in the survey area. This does not apply to turns when starting a new track line.

11.3. Protected Species Observers

Two marine mammal observers (PSOs) will be present on the main sonar vessel. The smaller skiff may only accommodate one at a time. Of these two PSOs, one will be on watch at all times, except ongoing sonar operations during darkness, to monitor the 50 m safety radius for the presence of marine mammals during sonar operations. The main objectives of the vessel-based marine mammal monitoring are as follows:

1. To implement mitigation measures during sonar operations (e.g. course alteration, power-down, shut-down and ramp-up);
2. To record all marine mammal data needed to estimate the number of marine mammals potentially affected, which must be reported to NMFS within 90 days after the survey.

11.3.1. Protected Species Observer Protocol

Hilcorp intends to work with PSOs who have had previous experience working on shallow geohazard survey vessels. All PSOs shall be trained and approved by NMFS. At least one Alaska

Native resident, who is knowledgeable about Arctic marine mammals and the subsistence hunt, is expected to be included as an additional team member aboard the vessels. Before the start of the sonar survey the crew of the vessel and skiff(s) will be briefed on the function of the PSOs, their monitoring protocol, and mitigation measures to be implemented.

The project will have two PSO aboard the source vessel and skiff(s) during the surveys. On all source vessels, at least one observer will monitor for marine mammals at any time during daylight hours (there will be no periods of total darkness until mid-August). PSOs will be on duty in shifts of a maximum of 4 hours at a time, although the exact shift schedule will be established by the lead PSO in consultation with the other PSOs.

All sonar source vessels will offer suitable platforms for marine mammal observations. Observations will be made from locations where PSOs have the best view around the vessel. During daytime, the PSO(s) will scan the area around the vessel systematically with reticle binoculars and with the naked eye. Because the main purpose of the PSO on board the vessel is detecting marine mammals for the implementation of mitigation measures according to specific guidelines, we prefer to keep the information to be recorded as concise as possible. This will allow the observer to focus on detecting marine mammals. The following information will be collected:

- Environmental conditions – consisting of sea state (in Beaufort Windforce scale according to NOAA), visibility (in km, with 10 km indicating the horizon on a clear day), and sun glare (position and severity). These will be recorded at the start of each shift, whenever there is an obvious change in one or more of the environmental variables, and whenever the observer changes shifts.
- Project activity – consisting of sonar activity (on or off), type, and line number. This will be recorded at the start of each shift, whenever there is an obvious change in project activity, and whenever the observer changes shifts.
- Sighting information – consisting of the species (if determinable), group size, position and heading relative to the vessel, behavior, movement, and distance relative to the vessel (initial and closest approach). These will be recorded upon sighting a marine mammal or group of animals.

11.3.2. Communication Procedures

When marine mammals in the water are detected within or about to enter the designated safety zones, the shut-down procedures will be implemented immediately. To assure prompt implementation of shut-downs, multiple channels of communication between the PSOs and the sonar technicians will be established. During the shut-down, the PSO(s) will continue to maintain watch to determine when the animal(s) are outside the safety radius. Sonar operations can be resumed if the observers have visually confirmed that the animal(s) moved outside the safety zone, or if the animal(s) were not observed within the safety zone for 15

minutes (seals) or for 30 minutes (whales). Direct communication with the sonar operator will be maintained throughout these procedures.

11.3.3. Data Recording

All marine mammal observations and any sonar shut-down / resumption will be recorded in a standardized format. Data will be entered into or transferred to a custom database. The accuracy of the data entry will be verified daily through QAQC procedures. Recording 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 other programs for further processing and archiving.

12. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

The project area does not contain any presently occupied human settlements but is recognized as a subsistence use area for residents of Nuiqsut, Kaktovik and Barrow.

Hilcorp considers participation in Conflict Avoidance Agreement (CAA) discussions with the Alaska Eskimo Whaling Commission (AEWC) and North Slope communities' Whaling Captains' Associations, as a key component of a Plan of Cooperation with the nearby communities with respect to subsistence hunting. In addition, Hilcorp plans to meet with representatives of the Ice Seal Committee. This stakeholder-driven approach to multi-use management has proven to be very effective in reducing conflicts (Lefevre 2013).

Hilcorp understands the importance of subsistence to the communities of Nuiqsut, Kaktovik and Barrow, and is currently establishing a dialogue for a Plan of Cooperation to coordinate activities with the villages that have the potential to influence or come into close proximity with subsistence users. A Plan of Cooperation will include the aforementioned mitigation measures (principally avoidance) and includes plans for and results of meetings with Alaska Native communities.

Liberty Unit was transferred to Hilcorp ownership along with the Northstar, Milne Point and Endicott facilities. BPXA coordinated with communities and stakeholders regarding the Liberty Unit work during the 2014 season:

- December 13 - 14, 2012: Meeting with the AEWC and Whaling Captains' Associations during the AEWC Quarterly meeting in Anchorage.

- February 7 - 8, 2013: CAA discussions with AEWC and Whaling Captains' Associations during the AEWC Annual Convention in Barrow.

Hilcorp plans to continue attending the above meetings and has engaged stakeholders and Native community members throughout 2014. A list of meetings follows:

- Informal engagement with AEWC - July 2014
- Meeting with Native Village of Barrow leadership – August 2014
- Meeting with NSB Wildlife Management Dept. – August 2014
- Meeting with NSB Assembly – August 2014
- Meeting with NSB Planning Commission – October 2014
- Presentation and discussion with AEWC – October 2014
- Meeting with NSB Jacob Adams and NSB Counsel – October 2014
- Cultural awareness/subsistence presentation and Q&A with Uum's Consulting – October 2014
- Meeting with KSOP and community meeting in Nuiqsut – December 2014

Additional activities will occur later this year and into the future:

- Meetings with key subsistence groups are planned for January 2015 in Barrow, Nuiqsut and Kaktovik to address the Liberty Shallow Geohazard Surveys.
- A project informational mailer with a request for and multiple opportunities provided for community feedback (traditional mail, e-mail, phone) will be sent to community members following the January meetings.
- Additional pre-season meetings maybe planned if needed to address additional requests for coordination. Any subsistence discussions will be documented and forwarded to the NMFS as part of this Plan of Cooperation.
- Hilcorp will provide updates to the project and their monitoring and mitigation measures during the NMFS Open-Water Meeting in Anchorage in 2015.

Since the survey area is very small and the sounds generated by the multibeam echosounder, sidescan sonar, and sub-bottom profiler are either outside the hearing range of marine mammals, or not strong enough to propagate at distances far enough to impact marine mammals that may be present, no conflicts with subsistence users are anticipated.

12.1. Stakeholder Engagement

Hilcorp has begun discussions with the Alaska Eskimo Whaling Commission (AEWC) to develop a Conflict Avoidance Agreement (CAA) intended to minimize potential interference with bowhead subsistence hunting. Hilcorp will attend and participate in the CAA meetings scheduled in 2015.

The CAA, when executed, will describe measures to minimize any adverse effects on the availability of bowhead whales for subsistence uses.

The North Slope Borough Department of Wildlife Management (NSB-DWM) will be consulted and the project will also be presented to the NSB Planning Commission, in January 2015. Hilcorp will hold meetings with key stakeholders in the community of Nuiqsut, Barrow, and Kaktovik to present the proposed project, address questions and concerns, and provide them with contact information of project management to which they can direct concerns during the survey.

Hilcorp will continue to engage with the affected subsistence communities regarding its Beaufort Sea activities. Hilcorp will meet formally and/or informally with several stakeholder entities; the North Slope Borough (NSB), NMFS, NSB Department of Wildlife Management (DWM), AEWC, Inupiat Community of the Arctic Slope (ICAS), Inupiat History Language and Culture Center (IHLC), USFWS, and ADF&G.

The following are measures that Hilcorp will take to reduce impacts to the subsistence community:

- Hilcorp will comply with the CAA terms to address plans to meet with the affected community to resolve conflicts and notify the communities of any changes in the operation. More detailed information about the mitigation measures that will be implemented to reduce impacts to marine mammals are outlined in Section 11 of this IHA request.
- Inupiat Marine Mammal Observers on board the vessels are tasked with looking out for whales and other marine mammals in the vicinity of the vessel to assist the vessel captain in avoiding harm to whales and other marine mammals.
- Vessels will be operated in a manner to avoid areas where species that are sensitive to noise or movement are concentrated at times when such species are concentrated.
- Communications and conflict resolution are detailed in the CAA. Hilcorp is planning to participate in the Communications Center that is operated annually during the bowhead subsistence hunt.
- Communications with the villages of Barrow, Kaktovik, and Nuiqsut – discuss community questions or concerns including all subsistence hunting activities.
- Hilcorp and contractors will follow a Polar Bear and Pacific Walrus Awareness and Interaction Plan addressing food and waste management, personnel training, and safety and communication regarding polar bears.

12.2. Future Plan of Cooperation Consultations

Hilcorp plans to engage with the relevant subsistence communities regarding its future Beaufort Sea activities. With regard to the 2015 Liberty Unit shallow geohazard survey project, Hilcorp will present the data on marine mammal sightings and the results of the marine mammal monitoring and mitigation as part of our 90-day report to the regulatory authorities.

13.MONITORING AND REPORTING PLAN

The 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 plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

In keeping with guidance provided by the NMFS in Section 5.3 of the 2013 Supplemental Draft Environmental Impact Statement (SDEIS), Hilcorp considered a number of monitoring and reporting opportunities that could contribute to the collective knowledge of marine mammals, marine mammal prey, and marine mammal habitat. Hilcorp proposes a passive acoustic monitoring plan as detailed by Jasco Applied Sciences in Attachment 1 to this IHA application. This acoustic monitoring plan has been designed to inform about ambient sound conditions and to quantify marine mammal presence in the vicinity of the project area in Foggy Island Bay. As described in Jasco's attached monitoring plan, passive acoustic monitoring will document ambient noise conditions, examine the spatial and temporal distribution of marine mammals based on acoustic detections of their vocalizations, and characterize the long-range propagation of sounds produced during the shallow hazard survey. The goal of the program is to address knowledge gaps about ambient sound levels and the distributions and migration paths of several marine mammal species including bowheads, belugas, and seals. The execution of Hilcorp's monitoring plan as proposed in this IHA is specific to and dependent upon Jasco Applied Science's project proposal.

13.1. Reporting

13.1.1. 90-day report

Hilcorp will submit a report to NMFS within 90 days after the end of the shallow geohazard survey summarizing relevant project information and results from the PSO program. Summaries of the project activities and results of the marine mammal monitoring and mitigation data will include the following information:

- Summary of project start and end dates, sonar activity, type of equipment, and the number and circumstances of implementing shutdown, and other mitigation actions.
- Marine mammal observation effort in total number of hours and total number of line kilometers. This will include a summary of environmental conditions that can affect marine mammal detection, such as visibility and sea state;
- A summary of marine mammal sighting information, such as species observed, group sizes, behavior, distribution, and the date and time of each sighting;

- A summary of sighting information related to sonar activity, including (a) marine mammal sighting rates; (b) sighting distances (initial and closest point of approach); and (c) observed behaviors and movements;
- An estimate of seal and whale exposures to sound levels of 160 dB re 1µPa (rms) and a comparison to the estimated exposures in the IHA application. Hilcorp cannot provide estimates of "takes" since it is impossible to determine which exposures would have resulted in a behavioral response that would be considered a "take" as defined by the MMPA.

14. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL HARASSEMENT

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

Provided that an acceptable methodology and business relationship can be worked out in advance, Hilcorp will work with any number of external entities, including other energy companies, agencies, universities, and NGOs, in its efforts to manage, understand, and fully communicate information about environmental effects related to activities that produce anthropogenic sound. Hilcorp is committed to an improved understanding of the cumulative effects of multiple sound sources.

15.LITERATURE CITED

Aerts, L.A.M. & W.J. Richardson (eds.). 2009. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2008: Annual Summary Report. LGL Rep. P1081. Rep. from LGL Alaska Res. Assoc. Inc. (Anchorage, AK), Greeneridge Sciences Inc. (Santa Barbara, CA) and Applied Sociocultural Res. (Anchorage, AK) for BP Exploration (Alaska) Inc., Anchorage, AK.

Aerts, L.A.M. & W.J. Richardson (eds.). 2010. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2009: Annual Summary Report. LGL Rep. P1132. Rep. from LGL Alaska Res. Assoc. Inc. (Anchorage, AK), Greenridge Sciences, Inc. (Santa Barbara, CA) and Applied Sociocultural Res. (Anchorage, AK) for BP Exploration (Alaska) Inc., Anchorage, AK. 142 p.

Aerts, L.A.M., M. Blees, S. Blackwell, C. Greene, K. Kim, D. Hannay & M. Austin. 2008. Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report. LGL Rep. P1011-1. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Research Ltd. for BP Exploration Alaska.

Aerts, L.A.M., W. Hetrick, S. Sitkiewicz, C. Schudel, D. Snyder, & R. Gumtow. 2013. Marine mammal distribution and abundance in the northeastern Chukchi Sea during summer and early fall, 2008-2012. Final Report prepared by LAMA Ecological for ConocoPhillips Company., Shell Exploration and Production Company and Statoil USA E&P, Inc.

ADNR. 2009. Division of Oil & Gas. Beaufort Sea Areawide Oil and Gas Lease Sale. Final Finding of the Director. November 9.

Allen, B.M. & R.P. Angliss. 2014. Alaska marine mammal stock assessments, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-277, 304 p.

Bacon, J. J., T. R. Hepa, H. K. J. Brower, M. Pederson, T. P. Olemaun, J. C. George &. G. Corrigan. 2009 Estimates of Subsistence Harvest for Villages On The North Slope Of Alaska, 1994-2003. North Slope Borough, Department of Wildlife Management.

Bengtson, J. L., L. M. Hiruki-Raring, M. A. Simpkins, and P. L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. Polar Biol. 28: 833-845.

Berzin, A.A., V.L. Vladimirov, and N.V. Doroshenko. 1990. Results of aerial surveys on distribution and abundance of bowhead, gray and white whales in Okhotsk Sea in 1985-89. Izvestiya TINRO. 112: 52-60. [in Russian].

Bogoslovskaya, L. S., L. M. Votrogov, and T. N. Semenova. 1981. Feeding habits of the gray whale off Chukotka. Rep. Int. Whaling Comm. 31: 507-510.

Boveng, P. L., J. L. Bengtson, T. W. Buckley, M. F. Cameron, S. P. Dahle, B. P. Kelly, B. A. Megrey, J. E. Overland, & N. J. Williamson. 2009. Status review of the spotted seal (Phoca largha). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-200. 153 p.

Braham, B., and D. Krogman 1977. Population biology of the bowhead (Balaena mysticetus) and beluga (Delphinapterus leucas) whale in the Bering, Chukchi and Beaufort Seas. NOAA, Northeast and Alaska Fisheries Center, Seattle, WA. Processed Rep. 29 pp.

Braham, B., D. Krogman, and C.H. Fiscus. 1977. Bowhead (Balaena mysticetus) and beluga (Delphinapterus leucas) whales in the Bering, Chukchi and Beaufort seas. In Environmental assessment of the Alaskan continental shelf. Annual Report 1:134-160. U.S. Dep. Commer., NOAA, Environ. Research Lab., Boulder, Colorado.

Brandon, J.R, T. Thomas, & M. Bourdon. 2011. Beaufort Sea aerial survey program results. (Chapter 6) In: Reiser, C.M, D.W. Funk, R. Rodrigues, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., NMFS, and USFWS. 240 pp, plus appendices.

Braund, S.R. 1992. Traditional Alaska Eskimo whaling and the bowhead quota. Arctic Research 6(Fall):37-42.

Brodie, P. F. 1989. The white whale Delphinapterus leucas (Pallas, 1776). In S. H. Ridgway & Sir R. Harrison (Eds.), Handbook of marine mammals (Vol 4.) River dolphins and the larger toothed whales (pp. 119-144). San Diego: Academic Press.

Brooks, J. w. 1954. Beluga investigations. 1954 Ann. Rep. Alaska Dept. Fisheries, Juneau 6:51-57.

Brooks, J. w. 1955. Beluga investigations. 1955 Ann. Rep. Alaska Dept. Fisheries, Juneau 7:98-106.

Brooks, J. W. 1956. Beluga investigations. 1956 Ann. Rep. Alaska Dept. Fisheries, Juneau 8:52-58.

Brooks, J. w. 1957. Beluga investigations. 1957 Ann. Rep. Alaska Dept. Fish and Game, Juneau 9:57-59.

Burns, J. J. 1967. The Pacific bearded seal. Alaska Department of Fish and Game, Pittman-Robertson Project Report W-6-R and W-14-R. 66 p.

Burns, J.J. 1981. Bearded seal Erignathus barbatus Erxleben, 1777. p. 145-170 In: S.H. Ridgway and R.J. Harrison (eds.), Handbook of Marine Mammals, Vol. 2: Seals. Academic Press, New York.

Burns, J. J. 2002. Harbor seal and spotted seal, Phoca vitulina and P. largha. Pages 552-560 in W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Burns, J. J., and K. J. Frost. 1979. The natural history and ecology of the bearded seal, Erignathus barbatus. Alaska Department of Fish and Game. 77 p.

Burns, J. J., L. H. Shapiro, and F. H. Fay. 1981. Ice as marine mammal habitat in the Bering Sea. Pages 781-797 in D. W. Hood and J. A. Calder, editors. The Eastern Bering Sea Shelf: Oceanography and Resources. Volume Two. U.S. Department of Commerce, NOAA, U.S. Department of Interior, Office of Marine Pollution Assessment, and Bureau of Land Management, Washington, DC.

Burns, J.J. & F.A. Seaman. 1985. Investigations of belukha whales in coastal waters of western and northern Alaska. Contract NA 81 RAC 00049. Fairbanks, AK:Alaska Department of Fish and Game, 129.

Cameron, M., and P. Boveng. 2007. Abundance and distribution surveys for ice seals aboard USCG Healy and the Oscar Dyson, April 10-June 18, 2007. Alaska Fisheries Science Center Quarterly Report, April-May-June 2007:12-14.

Cameron, M., and P. Boveng. 2009. Habitat use and seasonal movements of adult and sub-adult bearded seals. Alaska Fisheries Science Center Quarterly Report, October-November-December 2009:1-4.

Cameron, M.F., J. L. Bengtson, P.L. Boveng, J.K. Jansen, B.P. Kelly, S.P. Dahle, E.A. Logerwell, J.E. Overland, C.L. Sabine, G.T. Waring, & J.M. Wilder. 2010. Status review of the bearded seal (*Erignathus barbatus*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-211, 246 p.

Christie, K., C. Lyons, & W.R. Koski. 2010. Beaufort Sea aerial monitoring program. (Chapter 7) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, LGL Ltd., Greeneridge Sciences, and JASCO Research for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 pp. plus Appendices.

Clarke, J.T., C.L. Christman, M.C. Ferguson, and S.L Grassia. 2011a. Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2006-2008. Final Report, OCS Study BOEMRE 2010-042. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., C. L. Christman, S. L. Grassia, A. A. Brower and M. C. Ferguson. 2011b. Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2009. B. o. O. E. Management, editor. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, BOEM 2010-040. 7600 Sand Point Way NE, F/AKC3, Seattle, WA.

Clarke J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2012. Distribution and Relative Abundance of Marine Mammals in the Alaskan Chukchi and Beaufort seas, 2011. Annual Report, OCS Study BOEM 2012-009. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2013a. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J., K. Stafford, S. Moore, B. Rone, L. Aerts, and J. Crance. 2013b. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136–149.

Cooke, J.G., D.W. Weller, A.L. Bradford, A.M. Burdin, and R.L. Brownell, Jr. 2008. Population assessment of western gray whales in 2008. Paper SC/60/BRG 11 presented to the International Whaling Commission Scientific Committee. 9pp.

COSEWIC. 2004. COSEWIC Assessment and Update Status Report on the Narwhal, Monodon monoceros in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 50 pp.

Davis, R.A. and C.R. Evans. 1982. Offshore distribution and numbers of white whales in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. Rep. from LGL Ltd., Toronto, Ont., for Sohio Alaska Petrol. Co., Anchorage, AK, and Dome Petrol. Ltd., Calgary, Alb. (co-managers). 76 p.

Donovan, G.P. (ed.). 1982. Report of the International Whaling Commission (Special Issue 4). Aboriginal Subsistence Whaling (with special reference to the Alaska and Greenland fisheries). International Whaling Commission, Cambridge. 86pp.

EDAW/AECOM. 2007. Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting Activities in the Beaufort Sea. Prepared by EDAW, Inc. and Adams/Russell Consulting for U.S. Department of the Interior, Minerals Management Service.

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea. Pages 383-399 in D. W. Hood and E. J. Kelley, editors. Oceanography of the Bering Sea. Institute of Marine Science, Hakodate, Japan.

Fechhelm, R.G & S.W. Raborn. 2013. Year 30 of the long-term monitoring of nearshore Beaufort Sea fishes in the Prudhoe Bay region: 2012 annual report. Report for BP Exploration (Alaska) Inc. by LGL Alaska ResearchAssociates, Inc., Anchorage, Alaska. 82 pp.

Fedoseev, G. A. 2000. Population biology of ice-associated forms of seals and their role in the northern Pacific ecosystems. Center for Russian Environmental Policy, Russian Marine Mammal Council, Moscow, Russia. 271 p. (Translated from Russian by I. E. Sidorova, 271 p.).

Ferguson, M. C., and J. T. Clarke. 2013. Estimates of detection probability for BWASP bowhead whale, gray whale, and beluga sightings collected from Twin Otter and Aero Commander aircraft, 1989 to 2007 and 2008 to 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-261, 52 p.

Finneran, J..J. and C.E. Schlundt. 2007. Underwater sound pressure variation and bottlenose dolphin (*Tursiops truncatus*) hearing thresholds in a small pool. Journal of the Acoustical Society of America 122: 606-614.

Finneran, J.J., D.A. Carder, C.E. Schlundt and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of the Acoustical Society of America 118(4): 2696-2705.

Frost, K. J. 1985. The ringed seal (Phoca hispida). Pages 79-87 in J. J. Burns, K. J. Frost, and L. F. Lowry, editors. Marine Mammals Species Accounts. Alaska Department Fish and Game, Juneau, AK.

Frost, K. J. and L.F. Lowry. 1981. Ringed, Baikal and Caspian seals Phoca hispida Schreber, 1775; Phoca sibirica Gmelin, 1788 and Phoca caspica Gmelin, 1788. Pp. 29-53 in Handbook of marine mammals (S. H. Ridgway and R. J. Harrison, eds.). Academic Press, London, United Kingdom 2:1-359.

Frost, K. J., and L. F. Lowry. 1984. Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea. Pages 381-401 in P. W. Barnes, D. M. Schell, and E. Reimnitz, editors. The Alaskan Beaufort Sea ecosystems and environments. Academic Press, New York.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, Delphinapterus leucas, in coastal waters of western Alaska. Pp. 39-57 In T. G. Smith, D. J. St. Aubin, and J. R. Geraci (eds.), Advances in research on the beluga whale, Delphinapterus leucas. Can. Bull. Fish. Aquat. Sci. 224.

Frost, K. J., L. F. Lowry, J. J. Burns. 1983a. Distribution of marine mammals in the coastal zone of the Bering Sea during summer and autumn. Pages 365-561 In: Environmental Assessment of the Alaskan Continental Shelf, Final Rep. of Pricipal Investigators, Vol 20. NOAA, Outer Continental Shelf Environemntal Assessment Program, Juneau, AK.

Frost, K. J., L. F. Lowry, and R. R. Nelson. 1983b. Investigations of belukha whales in coastal waters of western and northern Alaska, 1982-1983: marking and tracking of whales in Bristol Bay. Final Rep. NOAA, Outer Continental Shelf Environmental Assessment Program Contract NA 81 RAC 00049. Alaska Dept. Fish and Game, Fairbanks. 104 p.

Frost, K. J., L. F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8-16.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2002. Monitoring distribution and abundance of ringed seals in northern Alaska. OCS Study MMS 2002-043. Final Rep. prepared by State of Alaska Department of Fish and Game, Juneau, AK, for U.S. Department of Interior, Minerals Management Service, Anchorage, AK. 66 p. + Appendices.

Frost, K. J., L. F. Lowry, G. Pendleton, and H. R. Nute. 2004. Factors affecting the observed densities of ringed seals, Phoca hispida, in the Alaskan Beaufort Sea, 1996-99. Arctic 57:115-128.

Frost, K. J., M. F. Cameron, M. Simpkins, C. Schaeffer, and A. Whiting. 2005. Diving behavior, habitat use, and movements of bearded seal (Erignathus barbatus) pups in Kotzebue Sound and Chukchi Sea. Pages 98-99 in Proceedings of the Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, CA. Society for Marine Mammalogy.

Frost, K. J., A. Whiting, M. F. Cameron, and M. A. Simpkins. 2008. Habitat use, seasonal movements and stock structure of bearded seals in Kotzebue Sound, Alaska. Tribal Wildlife Grants Program, Fish and Wildlife Service, Tribal Wildlife Grants Study U-4-IT. Final report from the Native Village of Kotzebue, Kotzebue, AK, for U.S. Fish and Wildlife Service, Anchorage, AK. 16 p.

Funk, D., D Hannay, D. Ireland, R. Rodrigues and W. Koski. (eds.). 2008. Marine mammal monitoring and mitigation during open water seismic in the Chukchi and Beaufort seas, July–November 2007: 90-day report. LGL Rep. P969-1. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore, Inc., NMFS, and USFWS. 218 pp plus appendices.

Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2011. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Galginaitis, M.S. and W.R. Koski. 2002. Kaktovikmiut whaling: historical harvest and local knowledge of whale feeding behavior. p. 2-1 to 2-30 (Chap. 2) In: W.J. Richardson and D.H. Thomson (eds.), Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information, vol. 1. OCS Study MMS 2002-012; LGL Rep. TA2196-7. Report from LGL Ltd., King City, Ont., for U.S. Minerals Management Service, Anchorage, AK, and Herndon, VA. 420 p.

Gambell, R. 1982. The bowhead whale problem and the International Whaling Commission. Report of the International Whaling Commission (IWC). Special Issue 4:1-6.

George, J.C., L.M. Philo, K. Hazard, D. Withrow, G.M. Carroll and R. Suydam. 1994. Frequency of killer whale (Orcinus orca) attacks and ship collisions based on scarring on bowhead whales (Balaena mysticetus) of the Bering-Chukchi-Beaufort seas stock. Arctic 47(3): 246-255.

George, J.C., J. Zeh, R. Suydam and C. Clark. 2004. Abundance and population trend (1978-2001) of Western Arctic bowhead whales surveyed near Barrow, Alaska. Mar. Mamm. Sci. 20(4): 755-773.

George, J. C., S. E. Moore, and R. Suydam. 2007. Summary of stock structure research on the Bering-Chukchi- Beaufort seas stock of bowhead whales 2003-2007. Report SC/59/BRG3 submitted to the IWC Scientific Committee. 15 pp.

Givens, G. H., S.L. Edmondson, J.C. George, R. Suydam, R.A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R. A DeLong, and C.W. Clark. 2013. Estimate of 2011 abundance of the Bering-Chukchi-Beaufort Seas bowhead whale population. Paper SC/65a/BRG01 submitted to the Scientic Committee of the International Whaling Commission, May 2013. 30 pp.

Green, G.A., and S. Negri. 2005. Marine Mammal Monitoring Program, FEX Barging Project, 2005. Report by Tetra Tech EC, Inc., Bothell, WA for ASRC Lynx Enterprises, Inc., Anchorage, AK.

Green, G.A., and S. Negri. 2006. Marine Mammal Monitoring Program, FEX Barging Project, 2006. Report prepared by Tetra Tech EC, Inc., Bothell, WA, for ASRC Lynx Enterprises, Inc., Anchorage, AK.

Green, G.A., K. Hashagen, and D. Lee. 2007. Marine mammal monitoring program, FEX barging project, 2007. Report prepared by Tetra Tech EC, Inc., Bothell, WA, for FEX L.P., Anchorage, AK.

Haley, B., J. Beland, D.S. Ireland, R. Rodrigues, and D.M. Savarese. 2010. Chukchi Sea vessel-based monitoring program. (Chapter 3) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

Harris, R.E., G.W. Miller and W.J. Richardson. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Mar. Mamm. Sci. 17(4):795-812.

Harwood, L.A. and I. Stirling. 1992. Distribution of ringed seals in the southeastern Beaufort Sea during late summer. Can. J. Zool. 70(5):891-900.

Hashagen, K.A., G.A. Green, and W. Adams. 2009. Observations of humpback whales, *Megaptera novaeangliae* in the Beaufort Sea, Alaska. Northwestern Naturalist 90:160-162.

Hauser, D.D.W., V.D. Moulton, K. Christie, C. Lyons, G. Warner, C. O'Neill, D. Hannay and S. Inglis. 2008. Marine mammal and acoustic monitoring of the Eni/PGS open-water seismic program near Thetis, Spy and Leavitt islands, Alaskan Beaufort Sea, 2008: 90-day report. LGL Rep. P1065-1. Rep. from LGL Alaska Research Associates Inc. and JASCO Research Ltd., for Eni US Operating Co. Inc., PGS Onshore, Inc., NMFS, and USFWS. 180 p.

Herreman, J.K., Douglas, D., Quakenbush, L., 2012. Movement and haulout behavior of ringed seals during the 2011 open water season. Abstract in: Marine Mammal Science Symposium, January 16–20, 2012, p. 128.

HDR, Inc. 2012. Marine Mammal Monitoring and Mitigation during BP Simpson Lagoon OBC Seismic Survey, Beaufort Sea, Alaska: 90-day Report. : 90-day report. Report from HDR, Inc. Anchorage, Alaska for BP Exploration Alaska.

IWC. 1980. Report of the Special Meeting on North Pacific Sperm Whale Assessments, Cronulla, November 1977. Report of the International Whaling Commission (Special Issue 2): 1-10.

Jankowski, M., H. Patterson, and D. Savarese. 2009. Beaufort Sea vessel–based monitoring program. (Chapter 6) In: Ireland, D.S., D.W. Funk. R. Rodrigues, and W.R. Koski (eds.). 2009. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2007. LGL Alaska Report P971–2, Report from LGL Alaska Research Associates, Inc., Anchorage, AK, LGL Ltd., environmental research associates, King City, Ont., JASCO Research, Ltd., Victoria, BC, and Greeneridge Sciences, Inc., Santa Barbara, CA, for Shell Offshore, Inc., Anchorage, AK, ConocoPhillips Alaska, Inc., Anchorage, AK, and the National Marine Fisheries Service, Silver Springs, MD, and the U.S. Fish and Wildlife Service, Anchorage, AK. 485 p. plus Appendices.

Johnson, M. L., C. H. Fiscus, B. T. Ostenson, and M. L. Barbour. 1966. Marine mammals. Pages 877-924 in N. J. Wilimovsky and J. N. Wolfe, editors. Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission, Oak Ridge, TN.

Kastelein, R.A., R. Gransler, L. Hoek, and J. Olthuis. 2012. Temporary hearing threshold shifts and recovery in a harbor porpoise (*Phocoeno phocoena*) after octave-band noise at 4 kHz. Journal of the Acoustical Society of America 132:3525-3537.

Kelly, B.P. 1988. Bearded seal, Erignathus barbatus. p. 77-94 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC. 275 p.

Kelly, B.P., O.H. Badajos, M. Kunnasranta and J. Moran. 2006. Timing and Re-interpretation of Ringed Seal Surveys. Final Report OCS Study MMS 2006-013. Prepared by Coastal Marine Institute, University of Alaska, 60 p.

Kelly, B. P., J. L. Bengtson, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J.E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010a. Status review of the ringed seal (Phoca hispida). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-212, 250 p.

Kelly B.P, O.H. Badajos, M. Kunnasranta , J.R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010b. Seasonal home ranges and fidelity to breeding sites among ringed seals. Polar Biology 33:1095–1109. DOI 10.1007/s00300-010-0796-x.

King, J.E. 1983. Seals of the World, 2nd ed. Cornell Univ. Press, Ithaca, NY. 240 p.

Kleinenberg, s. E., A. V. Yablokov, B. M. Belkovich, and M. N. Tarasevich. 1964. Beluga (Delphinapterus leucas) – Investigation of the species. Akad. Nauk SSSR, Moscow. 376 p. (In Russian, transl. by Israel ProgLrum for Sci. Trans!. Jerusalem, 1969).

Koski, W.R., D.W. Funk, D.S. Ireland, C. Lyons, A.M. Macrander and I. Voparil. 2008. Feeding by bowhead whales near an offshore seismic survey in the Beaufort Sea. Paper SC/60/E14 submitted to the IWC Scientific Committee. 14 p.

Koski, W.R., J. Zeh, J. Mocklin, A.R. Davis, D.J. Rugh, J.C. George, and R. Suydam. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (Balaena mysticetus) in 2004 estimated from photo-identification data. J. Cetacean Res. Manage. 11(2):89–99.

Krylov, V. I., G. A. Fedoseev, and A. P. Shustov. 1964. Pinnipeds of the Far East. Pischevaya Promyshlennost (Food Industry), Moscow, Russia. 55 p. (Translated from Russian by F. H. Fay and B. A. Fay, University of Alaska, Fairbanks, AK, 47 p.).

Laake, J.L., A.E. Punt, R. Hobbs, M. Ferguson, D. Rugh, and J. Breiwick. 2012. Gray whale southbound migration surveys 1967-2006: An integrated re-analysis. Journal of Cetacean Research and Management 12(3):287-306.

Leatherwood, S., A.E. Bowles, and R.R. Reeves. 1986. Aerial surveys of marine mammals in the southeastern Bering Sea. U.S. Department of Commerce, NOAA, OCSEAP Final Report 42:147-490.

Lefevre, J.S. 2013. A pioneering effort in the design of process and law supporting integrated Arctic Ocean management. Environmental Law Reporter, News and Analysis, 43 ELR 10894, 16pp.

Lensink, C. J. 1961. Status report: beluga studies. Unpubl. Rep. Alaska Dept. Fish and Game, Juneau. 20 p.

Ljungblad, D.K., S.E. Moore, and D.R.van Schoik. 1986. Seasonal patterns of distribution, abundance, migration and behavior of the Western Arctic stock of bowhead whales, *Balaena mysticetus* in Alaskan seas. Report of the IWC, Special Issue 8: 177:205.

Ljungblad, D.K., S.E. Moore, J.T. Clarke, and J.C. Bennett. 1987. Distribution, abundance, behavior and bioacoustics of endangered whales in the Alaskan Beaufort and eastern Chukchi seas, 1979-86. NOSC Technical Report 1177. OCS Study MMS 87-0039. Report from Naval Ocean Systems Center, San Diego, CA, for MMS, Anchorage, AK 391 p. NTIS PB88-116470.

Lowry, L.F., K.J. Frost, and G.A. Seaman. 1985. Investigations of belukha whales in coastal waters of western and northern Alaska. Vol. 3: Food habits. Final Report, National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program Contract NA 81 RAC 00049. Fairbanks, Alaska: Alaska Department of Fish and Game.

Lowry, L.F., K.J. Frost, R. Davis, D.P. DeMaster and R.S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi seas. Polar Biol. 19(4): 221-230.

Lucke, K., P.A. Lepper, M.A. Blanchet and U. Siebert. 2008. Testing the acoustic tolerance of harbour porpoise hearing for impulsive sounds. Submitted to Loughborough's Institutional Repository: 329-331

Lyons, C., W.R. Koski, and D.S. Ireland. 2009. Beaufort Sea aerial marine mammal monitoring program. (Chapter 7) In: Ireland, D.S., D.W. Funk, R. Rodrigues, and W.R. Koski (eds.). Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2007. LGL Alaska Report P971-2. Report from LGL Alaska Research Associates, Inc., Anchorage, AK, LGL Ltd., environmental research associates, King City, Ont., JASCO Research Ltd., Victoria, B.C., and Greeneridge Sciences, Inc., Santa Barbara, CA, for Shell Offshore, Inc., Anchorage AK, ConocoPhillips Alaska, Inc., Anchorage, AK, and the National Marine Fisheries Service, Silver Springs, MD, and the U.S. Fish and Wildlife Service, Anchorage, AK. 485 p. plus Appendices.

Maher, W.J. 1960. Recent records of the California gray whale (*Eschrichtius glaucus*) along the north coast of Alaska. Arctic 13(4): 257-265.

Maminov, M.K. and S.A., Blokhin. 2004. Gray whales (Eschrichtius robustus) in coastal waters of southern Far East. Marine Mammals of the Holarctic, Collection of Scientific Papers. Moscow. KMK: 362-368.

Marquette, W.M. 1976. Bowhead whale studies in Alaska, 1975. Mar. Fish. Rev. 38(8): 9-17.

Marquette, W.M. 1977. The 1976 catch of bowhead whales (Balaena mysticetus) by Alaskan Eskimos, with a review of the fishery, 1973 – 1976, and a biological summary of the species. Processed Rep. NOAA, Northwest and Alaska Fisheries Center, Seattle, WA. 80pp.

Marquette, W.M. 1979. The 1977 catch of bowhead whales (Balaena mysticetus) by Alaskan Eskimos. Rep. Int. Whal. Comm. 29: 281-289.

Mead, J.G. and E.D. Mitchell. 1984. Atlantic gray whales. In: The Gray Whale Eschrichtius robustus. Academic Press, Orlando, FL., pp. 33–53.

Miller, G.W., R.E. Elliot, T.A. Thomas, Moulton, V.D. and W.R. Koski. 2002. Distribution and numbers of bowhead whales in the eastern Alaska Beaufort Sea during late summer and autumn, 1979-2000. In: Richardson, W.J. and D.H. Thomson (eds). 2002. Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information. OCS Study MMS 2002-012; LGL Rep. TA2196-7. 697 p. 2 vol.

Miller, G.W., V.D. Moulton, R.A. Davis, M. Holst, P. Millman, A. MacGillivray and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002. p. 511-542 In: S.L. Armsworthy, P.J. Cranford, and K. Lee (eds.), Offshore Oil and Gas Environmental Effects Monitoring/Approaches and Technologies. Battelle Press, Columbus, OH.

Monnett, C. and S.D. Treacy. 2005. Aerial surveys of endangered whales in the Beaufort Sea, fall 2002-2004. OCS Study MMS 2005-037. Minerals Management Service, Anchorage, AK. xii + 153 p.

Moore, S.E., and J.T. Clarke. 1992. Distribution, Abundance and Behavior of Endangered Whales in the Alaskan Chukchi and Western Beaufort Seas, 1991: With a Review 1982–91. OCS Study MMS 92-0029, 126 pp. plus appendices.

Moore, S.E. and R.R. Reeves. 1993. Distribution and movement. p. 313-386 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Spec. Publ. 2. Soc. Mar. Mammal., Lawrence, KS. 787 p.

Moore, S.E., J.T. Clarke and D.K. Ljungblad. 1989. Bowhead whale (Balaena mysticetus) spatial and temporal distribution in the central Beaufort Sea during late summer and early fall 1979 86. Rep. Int. Whal. Comm. 39:283 290.

Moore, S.E., D.P. DeMaster and P.K. Dayton. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. Arctic 53(4):432-447.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-46 In: W.J. Richardson and J.W. Lawson (eds.), Marine mammal monitoring of WesternGeco's open-water seismic program in the Alaskan Beaufort Sea, 2001. LGL Rep. TA2564-4. Rep. from LGL Ltd., King City, Ont., for WesternGeco LLC, Anchorage, AK; BP Explor. (Alaska) Inc., Anchorage, AK; and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 95 p.

Moulton, V.D., R.E. Elliot and M.T. Williams and C. Nations. 2002. Fixed wing aerial surveys of seals near BP's Northstar and Liberty sites, 2002. Chapter 4, In: W.J. Richardson and M.T. Elliot (eds) 2003. Monitoring of industrial sounds, seals and bowhead whales near BP's Northstar Oil development, Alaskan Beaufort Sea, 1999-2002. Report from LGL Ltd., Greeneridge Sciences Inc. for BP Exploration (Alaska) Inc., Anchorage, AK and NMFS, Anchorage, AK and Silver Spring, M.D.

Nambu, H., H. Ishikawa, and T.K. Yamada. 2010. Records of the western gray Whale Eschrichtius robustus: its distribution and migration. Japan Cetology (20):21-29.

NMFS. 2000. Small takes of marine mammals incidental to specified activities; marine seismic-reflection data collection in southern California/Notice of receipt of application. Federal Register 65 (No. 60, 28 March 2000): 16374-16379.

NMFS. 2005. Endangered fish and wildlife; Notice of Intent to prepare an Environmental Impact Statement. Federal Register 70 (No. 7, 11 January 2005): 1871-1875.

NMFS. 2009. Proposed threatened and not warranted status for distinct population segments of the spotted seal. Federal Register 74 (No. 201, 20 October 2009): 53683-53696.

NMFS. 2012a. Endangered and Threatened Species; Threatened status for the Beringia and Okhotsk Distinct Population Segments of the *Erignathus barbatus nauticus* subspecies of the bearded Seal; Final Rule. Federal Register 77 (No. 249, 28 December 2012): 76740-76768.

NMFS. 2012b. Endangered and Threatened Species; Threatened status for the Arctic, Okhotsk, and Baltic subspecies of the ringed Seal and Endangered status for the Ladoga subspecies of the ringed Seal; Final Rule. Federal Register 77 (No. 249, 28 December 2012): 76706-76738.

NMFS. 2013a. Endangered and Threatened Wildlife; Determination on Whether to List the Ribbon Seal as a Threatened or Endangered Species. Notice. Federal Register 78 (No. 132, 10 July 2013): 41371-41384.

NMFS. 2013b. Effects of Oil and Gas Activities in the Arctic Ocean: Supplemental Draft Environmental Impact Statement. Prepared by NOAA, NMFS. 1408 pp.

NOAA. 2013. Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. NOAA-NMFS-2013-0177-0001. Draft Report. 76 pp.

Pike, G. C. 1962. Migration and feeding of the gray whales (Eschrichtius rabus/us). J. Fish. Res. Board Can. 19:815-838.

Patten, D. R., and W. F. Samaras. 1977. Unseasonable occurrences of gray whales. Bull. South. Calif. Acad. Sci. 76:205-208.

Popov V.V., V.O. Klishin, D.J. Nechaev, M.G. Pletenko, V.V. Rozhnov, A.Ya. Supin, E.V. Sysueva and M.B. Tarakanov. 2011. Influence of Acoustic Noises on the White Whale Hearing Thresholds. Ooklady Biological Sciences 40: 332-334.

Quakenbush, L.T. 1988. Spotted seal, Phoca largha. p. 107-124 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC. 275 pp.

Quakenbush, L.T., J.J. Citta, J.C. George, R.J. Small & M.P. Heide-Jorgensen. 2010. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and within a potential petroleum development area. Arctic 63(3): 289-307.

Rice, D.W., and A. A. Wolman. 1971. The life history and ecology of the gray whale (Eschrich/ius rabus/us). Am. Soc. Mammal., Spec. Publ. 3, 142 p.

Rice, D.W., A.A. Wolman, and H.W. Braham. 1984. The gray whale, Eschrichtius robustus. Marine Fisheries Review 46(4): 7-14.

Richardson W.J. and D.H. Thomson (Eds). 2002. Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information. Report prepared by LGL Ltd., King City, Ontario, Canada. OCS Study MMS 2002-012.

Rugh, D.J. and M.A. Fraker. 1981. Gray whale (Eschrichtius robustus) sightings in eastern Beaufort Sea. Arctic 34(2): 186-187.

Rugh, D.J., K.E.W. Shelden and D.E. Withrow. 1997. Spotted seals, Phoca largha, in Alaska. Marine Fisheries Review 59(1): 1-18.

Rugh, D.J., Hobbs, R.C., Lerczak, J.A. and Breiwick, J.M. 2005. Estimates of abundance of the Eastern North Pacific stock of gray whales 1997 to 2002. Journal of Cetacean Research and Management 7(1): 1-12.

Savarese, D.M., C.M. Reiser, D.S. Ireland, R. Rodrigues. 2010. Beaufort Sea vessel-based monitoring program. (Chapter 6) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and NMFS, USFWS, 506 pp, plus Appendices.

Schlundt, C.E., JJ. Finneran, D.A. Carder and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. Journal of the Acoustical Society of America 107: 3496-3508.

Seaman, G.A., and J.J. Burns. 1981. Preliminary results of recent studies of belukhas in Alaskan waters. Rep. Int. Whaling Comm. 31: 567-574.

Seaman, G.A., K.J. Frost, and L.F. Lowry. 1985. Distribution, abundance, and movements of belukha whales in western and northern Alaska. Draft final rep. Prepared for U.S. Dep. Commer., NOAA, Natl. Ocean Serv., Anchorage, Alaska. Alaska Dep. Fish and Game, Fairbanks.

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biology 26:577-586.

Smith, T.G. 1987. The ringed seal, Phoca hispida, of the Canadian Western Arctic. Canadian Bulletin Fisheries Aquatic Sciences 216: 81 p.

Smultea, M.A., M. Holst, W.R. Koski and S. Stoltz. 2004. Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic program in the Southeast Caribbean Sea and adjacent Atlantic Ocean, April-June 2004. LGL Rep. TA2822-26. Report from LGL Ltd. for Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, and National Marine Fisheries Service, Silver Spring, MD. 106 pp.

Sokolov V.E. and V.A. Arsen'ev. 1994. Baleen whales. In: Mammals of Russia and adjacent regions. M.: Nauka: 208 p. [in Russian].

Southall, B.L., R. Braun, F.M.D. Gulland, A.D. Heard, R.W. Baird, S.M. Wilkin & T.K. Rowles. 2006. Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31. 73pp.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals.

Southall, B.L., T. Rowles, F. Gulland, R.W Baird, & P.D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar.

Sprague, J. G., N. B. Miller, and J. L. Sumich. 1978. Observations of gray whales in Laguna de San Quintin, northwestern Baja California, Mexico. J. Mammal. 59:425427.

Stafford K.M., S.E. Moore, M. Spillane, and S. Wiggins. 2007. Gray Whale Calls Recorded near Barrow, Alaska, throughout the Winter of 2003– 04. Arctic 60(2): 167– 172.

Stirling, I., W. R. Archibald, and D. DeMaster. 1977. Distribution and abundance of seals in the eastern Beaufort Sea. Journal of the Fisheries Research Board of Canada 34:976-988.

Stirling, I., M. Kingsley, and W. Calvert. 1982. The distribution and abundance of seals in the eastern Beaufort Sea, 1974-79. Environment Canada, Canadian Wildlife Service, Edmonton, Canada. 25p.

Suydam, R.S. and J.C. George. 2012. Preliminary analysis of subsistence harvest data concerning bowhead whales (Balaena mysticetus) taken by Alaskan Natives, 1974 to 2011. Paper SC/64/AWMP8 presented to the IWC Scientific Committee.

Suydam, R.S., L.F. Lowry, and K.J. Frost. 2005. Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn. OCS Study MMS 2005-035. 35 p.

Suydam, R., JC. George, C. Rosa, B. Person, C. Hanns, and G. Sheffield. 2010. Subsistence harvest of bowhead whales (Balaena mysticetus) by Alaskan Eskimos during 2009. Paper SC/62/BRG18 presented to the IWC Scientific Committee.

Swartz, S.L., B.L. Taylor, and D.J. Rugh. 2006. Gray whale Eschrichtius robustus population and stock identity. Mammal Review 36: 66-84.

Tikhomirov, E. A. 1964. Distribution and biology of pinnipeds in the Bering Sea (from materials of the first expedition in 1962). Pages 277-285 in P. A. Moiseev, editor. Soviet Fisheries Investigations in the Northeast Pacific, Part III. Pischevaya Promyshlennost (Food Industry), Moscow, Russia. (Translated from Russian by Israel Program for Science Translations, Jerusalem, Israel, 9 p.).

Tikhomirov, E. A. 1966. Reproduction of seals of the family Phocidae in the North Pacific. Zoologicheskii Zhurnal 45:275-281. (Translated from Russian by Translation Bureau, Department of the Secretary of State of Canada, 19 p.).

Treacy, S.D., J.S. Gleason and C.J. Cowles. 2006. Offshore distances of bowhead whales (Balaena mysticetus) observed during fall in the Beaufort Sea, 1982-2000: an alternative interpretation. Arctic 59(1): 83-90.

Ver Hoef, J. M., J. M. London, and P. L. Boveng. 2010. Fast computing of some generalized linear mixed pseudomodels with temporal autocorrelation. Comp. Stat. 25:39-55.

Warner, G. & A. McCrodan. 2011. Underwater Sound Measurements. (Chapter 3) In: Hartin K.G., LN. Bisson, S.A. case, D.S. Ireland & D. Hannay (eds.). 2011. Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August-october 2011: 90-day report. LGL Rep. P1193. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Statoil USA E&P Inc., NMFS, and USFWS. 202 pp, plus appendices.

Weller, D.W., B. Wursig, A.B. Burdin, S.H. Reeve, A.L. Dradford, S.A. Blokhin, and R.L. Brownell. 1999. The occurrence, distribution and site fidelity of western gray whales off Sakhalin Island, Russia. Abstr. Of the 13-th Biennial Conf. on the Biology of Marine Mammals: 199.

Wolfe, R.J. and R.J. Walker. 1987. Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts. Arctic Anthropology 24(2): 56-81.

Woodby, D.A. and D.B. Botkin. 1993. Stock sizes prior to commercial whaling. p. 387-407 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Special Publication 2. Society Marine Mammology, Lawrence, KS. 787 pp.