ConocoPhillips

APPLICATION FOR INCIDENTAL HARASSMENT AUTHORIZATION FOR THE NON-LETHAL HARASSMENT OF CETACEANS AND SEALS DURING EXPLORATION DRILLING ACTIVITIES IN THE DEVILS PAW PROSPECT, CHUKCHI SEA, ALASKA

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Prepared by:

LAMA ecological

4311 Edinburgh Drive
Anchorage, AK 99502

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ACRONYMS AND ABBREVIATIONS

~	approximately
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to
%	percent
0-p	zero to peak
2D	two-dimensional
3D	three-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AHD	acoustic harassment device
AHST	anchor-handling supply tug
ATOC	Acoustic Thermometry of Ocean Climate program
BCB	Bering-Chukchi-Beaufort
BOEM	Bureau of Ocean Energy Management
BOP	blowout preventer
BSEE	Bureau of Safety and Environmental Enforcement
bsl	below sea level
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	centimeter(s)
Com-Station	Communication Station
COMIDA	Chukchi Offshore Monitoring in Drilling Area
COP	ConocoPhillips Company
CSESP	Chukchi Sea Environmental Studies Program
dB	decibel
DMS	degrees, minutes, seconds
ESA	Endangered Species Act
ft	foot/feet
HLV	heavy-lift vessel
hr(s)	hour(s)

HP	horse power
Hz	hertz
IHA	Incidental Harassment Authorization
In	inch(es)
in^3	cubic inches
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
KBRW	AM Radio Station in Barrow
kHz	kilohertz
km	kilometer(s)
km^2	square kilometers
KOTZ	Radio Station in Kotzebue
kph	kilometers per hour
LOA	letter of authorization
m	meter(s)
mi	mile(s)
mi^2	square miles
min	minutes
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
NMFS	National Marine Fisheries Service
NSB	North Slope Borough
MODU	mobile offshore drilling unit
OCS	Outer Continental Shelf
OSRB	oil spill response barge
OSRP	oil spill response plan
OST	oil storage tanker
OSRV	oil spill response vessels
OSV	offshore supply vessel
p-p	peak to peak
PCD	Pre-Positioned Capping Device
POC	Plan of Cooperation
PSO	Protected Species Observer
PTS	permanent threshold shift

re 1 µPa	relative to 1 microPascal
re 1 $\mu Pa^2 s$	relative to 1 square microPascal over a one second period
rms	root mean square
SEL	sound exposure level
SPL	sound pressure level
TD	total depth
TTS	temporary threshold shift
USFWS	U.S. Fish and Wildlife Service
VSP	Vertical Seismic Profile

EXECUTIVE SUMMARY

ConocoPhillips Company (hereafter referred to as COP) seeks authorization for non-lethal incidental "level B harassment" of marine mammals pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) during its proposed 2014 exploration drilling project in the Devils Paw prospect, Chukchi Sea. COP proposes to drill one or two exploration wells on the Outer Continental Shelf (OCS) in the Chukchi Sea, during the open water season, with a contingency to commence drilling in 2015 or 2016 if conditions to drill are not met in 2014. Weather and ice conditions, permitting approvals and other factors would dictate when drilling can commence, and unforeseen delays may occur. The drilling will be conducted using a jack-up rig and a variety of vessels to support the drill rig operations. The purpose of exploration drilling of the wells in the Devils Paw prospect is to test whether oil deposits are present in a commercially viable quantity and quality.

Eight species of cetaceans are known to occur in the Chukchi Sea. Three species (bowhead, fin and humpback whales) are listed as endangered under the Endangered Species Act (ESA). The marine mammal species under NMFS jurisdiction most likely to occur in the Devils Paw prospect include five cetacean species (beluga, bowhead, gray and killer whales, and harbor porpoises), and four pinniped species (ringed, spotted, bearded, and ribbon seals). The other three cetacean species (humpback whale, fin whale, and minke whale) are rare or extralimital for the northeastern Chukchi Sea and either are unlikely to be encountered in the Devils Paw prospect or only in very low numbers. COP is proposing a marine mammal monitoring and mitigation program to minimize any potential impacts of the proposed exploration drilling activity on marine mammals, and to document the nature and extent of any effects.

The items required to be addressed pursuant to 50 C.F.R. §216.104, "Submission of Requests" are set forth below. This includes descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor behavioral effects of marine mammals from the planned activities. An application for a Letter of Authorization (LOA) will be submitted separately to the U.S. Fish & Wildlife Service (USFWS) with regard to potential effects on species managed by USFWS – the Pacific walrus and polar bear.

1. 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 marine mammals.

ConocoPhillips Company (COP) proposes to drill one or two exploration wells on the Outer Continental Shelf (OCS) in the Chukchi Sea, during the open water period in the summer of 2014, with a contingency to commence drilling in 2015 or 2016 if conditions to drill are not met in 2014. Weather and ice conditions, permitting approvals and other factors would dictate when drilling can commence, and unforeseen delays may occur.

COP holds mineral exploration rights to 50 adjoining lease blocks surrounding the Klondike well drilled by Shell in 1989 (Figure 1). Drilling will be conducted using a jack-up rig and a variety of vessels to support the drill rig operations. Due to the lead time in obtaining all required permits and the variable availability of rigs and vessels, no specific drill rig or vessels have been contracted to date. COP has prepared this application based on a representative drill rig and associated vessels and will contract a rig and vessels with parameters similar to those described herein. If the contracted drill rig and/or vessels differ significantly from those described in this application, COP will submit an amendment to address the changes where required.

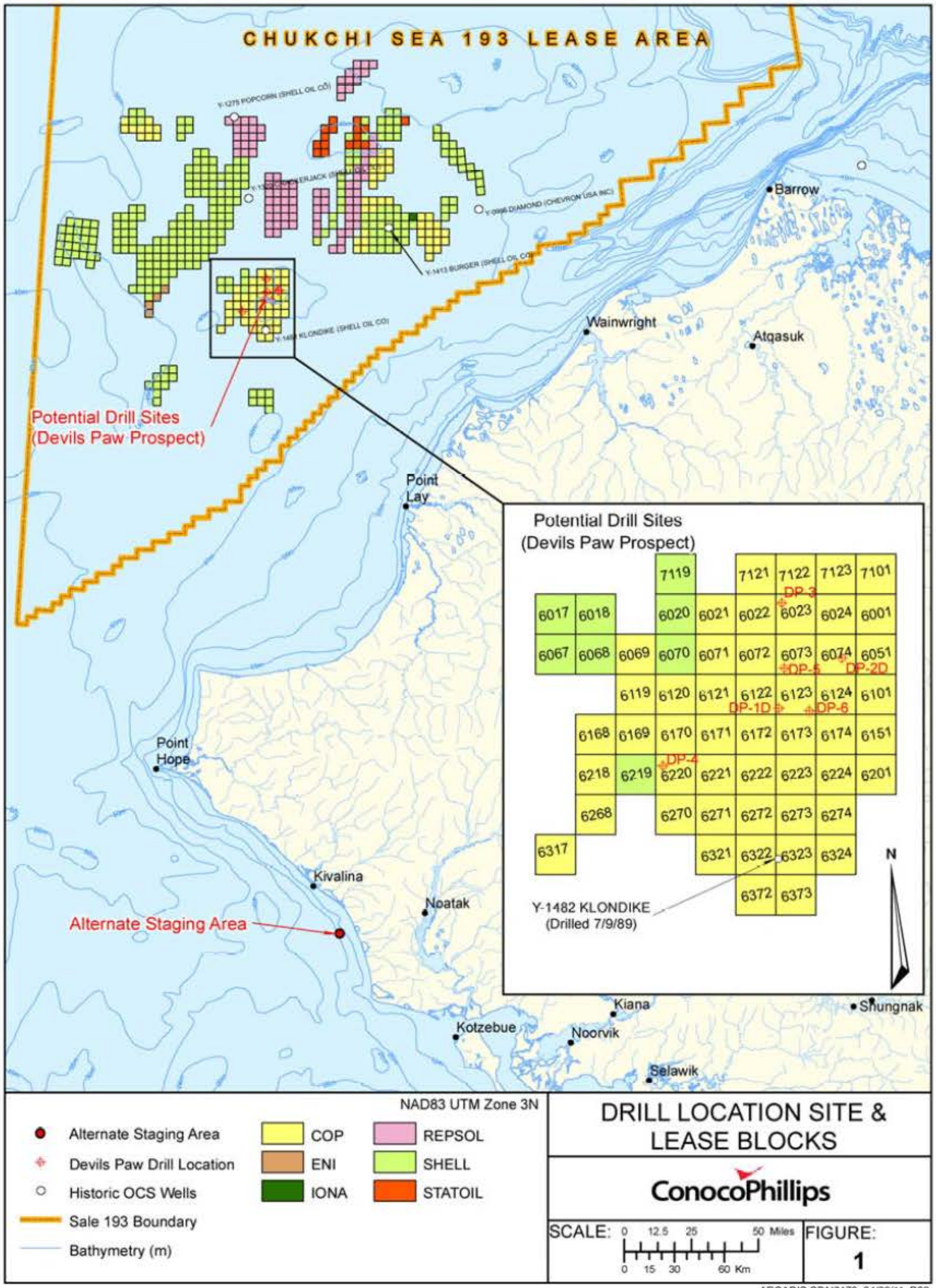
1.1 Purpose

The purpose of exploration drilling of wells in the Devils Paw prospect (Figure 1) is to test whether oil deposits are present in a commercially viable quantity and quality. In 2006, a marine seismic survey was carried out in this prospect and produced a detailed three-dimensional (3D) image of the subsurface structures. Through interpretation of this data, geologists and geophysicists were able to identify rock formations with oil-bearing potential. The proposed 2014 exploration drilling will be conducted to verify the presence of oil and determine its quantity and quality. Only if a significant accumulation of hydrocarbons is discovered will COP consider proceeding with development and production of the field.

1.2 Project Details

The jack-up rig and support vessels will be scheduled to arrive in Lease Sale Area 193 of the Chukchi Sea on or about July 1, a time period which has coincided with the retreat of sea ice in most years. If the well site is not free of ice at the scheduled arrival time, the rig will be offloaded at an alternate staging area until ice conditions are favorable for setting up the rig. Activities that are part of the drilling operation include: (1) drill rig mobilization and positioning, (2) ice management, (3) drill rig resupply, (4) personnel transfer, (5) refueling, (6) oil spill response capability, and (7) drill rig demobilization. In addition, vertical seismic profile (VSP) data acquisition runs will be conducted from the rig. Details of each of these activities are provided below. To mitigate potential impacts to subsistence hunting, COP will maintain close communications with representatives from the villages along the coast during rig and nearshore vessel transportation.

Figure 1 COP's Devils Paw Prospect with Locations of Proposed Exploration Drilling Sites



Note: Primary candidate drilling sites for 2014 are in Blocks 6073 and 6074.
Source: COP

1.2.1 Drill Rig Mobilization and Positioning

Generally, jack-up rigs consist of a buoyant steel hull with three or more legs on which the hull can be “jacked” up or down. The jack-up drill rig has no self-propulsion capability and therefore needs to be transported by a heavy-lift vessel (HLV) from its original location to an area in the Bering Sea where it would then be placed in a floating mode under the control of three towing vessels. After delivering the jack-up rig, the HLV would depart immediately via the Bering Strait and would not return until completion of the project. When weather and ice conditions at the Devils Paw Prospect are favorable, the support vessels will tow the rig into position over the DP-5 drill site and initiate offloading.

Offloading procedures are estimated to take from 24 to 36 hours (hrs), dependent on weather. Initial drill rig placement and orientation would be determined by, but not limited to, logistics, current and forecasted weather events, ice extent, ice type, underwriter requirements, and safety considerations. Actual positioning of the rig would be determined by the well design, geology, shallow hazards, and seabed conditions. The rig would then be jacked up, manned with a crew, and provisioned for commencing drilling. The horizontal dimensions of the rig will be approximately 230 × 225 feet (ft) or 70 × 68 meters (m). The water depth at DP-5 is approximately 140 ft (45 m). When operating, the hull will be about 40 ft (12 m) above seawater surface. Maximum dimension of one leg spud can, which is the part on the seafloor, is about 60 ft (18 m).

If weather and ice conditions at the Devils Paw Prospect area are initially unfavorable, the HLV would transport the jack-up rig to the alternate staging area located about 20 mi south of Kivalina and 6 mi offshore (see Figure 1), offload the rig, and depart the Chukchi Sea via the Bering Strait. This alternative location has been chosen based on its proximity to infrastructure and likelihood to be ice free at the time of transfer. It may take up to three days to reach the prospect location from the alternate staging area (approximately 190 miles [mi]).

If the rig is offloaded at the alternate staging area, it would be placed into standby mode, which means it would be temporarily jacked up and manned by a limited crew to wait for conditions to improve. In addition, support helicopters would be mobilized to Red Dog Mine near Kotzebue as necessary. Once ice conditions and weather at the Devils Paw Prospect area turn favorable, the anchor handling supply tug (AHST) and other vessels standing by in the immediate vicinity of the rig would move the rig to the prospect area. The rig would then be jacked up, manned with a crew, and supplied to commence drilling.

1.2.2 Ice Management

Understanding ice systems and monitoring their movement are important aspects of COP’s Chukchi Sea operations. COP has monitored Chukchi Sea ice since 2008 and would continue that monitoring through the proposed drilling season. Initial monitoring would incorporate satellite imagery to observe the early stages of sea ice retreat. Upon arrival in the project area, the ice management vessel, possibly with one other project vessel, would operate at the edge of the ice pack and monitor ice activity, updating all interested parties on ice pack coordinates to help determine scheduling for mobilization of the rig. COP has submitted an *Ice Alerts Plan* to Bureau of Ocean Energy Management (BOEM) for approval in connection with the Exploration Plan. The *Ice Alerts Plan* summarizes historic ice monitoring results which has assisted COP in estimating the timing and placement of the rig and support vessels. Under the COP *Ice Alerts Plan*, an ice monitoring and management center based out of Anchorage will monitor and interpret information collected from project vessels and satellite imagery during the entire drilling operation. A summary of the major components of COP's Ice Alerts Plan is provided below.

The ice edge position will be tracked in near real time using observations from satellite images, from the ice management vessel or other project vessels. The ice management and project vessels used for ice observations will remain on standby within about 5.5 mi of the drill rig, unless deployed to investigate migrating ice-floes. When investigating ice, the vessels will likely stay within about 75 mi of the rig. The *Ice Alerts Plan* includes a process for determining how close hazardous ice can approach before the well needs to be secured and the jack-up rig moved. This critical distance is a function of rig operations at that time, the speed and direction of the ice, the weather forecast, and the method of ice management.

Based on available historical and more recent ice data, there is low probability of ice entering the drilling area during the open water season. However, if hazardous ice is on a trajectory to approach the rig, the ice management vessel will be available to respond. One option for responding is to use the vessels fire monitor (water cannon) to modify the trajectory of the floe. Another option is to redirect the ice by applying pressure with the bow of the ice management vessel, slowly pushing the ice away from the direction of the drill rig. At these slow speeds, the vessel would use low power and slow propeller rotation speed, thereby reducing noise generation from propeller rotation effects in the water. Ice breaking is not planned as a way to manage ice that may be on a trajectory toward the drilling rig. In case the jack-up rig needs to be moved due to approaching ice, the support vessels will tow the rig to a secure location.

1.2.3 Drill Rig Resupply

Transport of supplies to and from the drill rig will primarily be done with the ware vessel and offshore supply vessels (OSVs), although any other project vessel with the capability of dynamic positioning could be used. The supplies will be loaded in Wainwright onto the large landing craft from where they will be transferred to the supply vessels. This transfer of supplies will take place somewhere between 5.5 mi of the drill rig and 5 mi offshore of Wainwright. When not engaged in transfers of supplies, the ware vessel and OSVs will be located about 5.5 mi of the drill rig. The large landing craft will be located somewhere between 5.5 mi of the drill site and 5 mi offshore of Wainwright.

The duration of each supply trip by the ware vessel and OSV is estimated to be up to 7 hrs, assuming the vessels depart from their standby location at about 5.5 mi of the rig. It would take approximately 0.5 hour to travel one-way to the drill rig (cruising mode). The supply vessel would be dynamically positioned next to the rig for about 6 hrs for each transfer of fuel and less than 6 hrs for each transfer of other supplies. The transit time between the large landing craft and the supply vessels is about 3 hrs one-way.

The ware vessel is estimated to make about two to three trips per week to the rig, but could make an average of almost four resupply trips per week over 14 weeks. Based on an estimated 53 trips per season and a maximum of 6 hrs for supply transfer, the ware vessel would be in dynamic positioning mode up to a total of 318 hrs over the drilling season. The OSVs are estimated to make four and a half resupply trips per week over 14 weeks. Based on an estimated total of 63 trips, unloading supplies from the OSV to the rig would take up to a total of 378 hrs (in dynamic positioning mode) over the course of the drilling season. Assuming that at any time only one supply vessel will be in dynamic positioning alongside the drill rig, the total duration of dynamic positioning is 696 hrs.

1.2.4 Personnel Transfer

About 300 persons are estimated to be involved in the proposed exploration drilling overall. The jack-up drill rig, support and oil spill response vessels will be self-contained, and the crew will live aboard the rig and vessels. Air support will be necessary to meet personnel and supply needs once the rig is operational. Wainwright will be the principal port from which crew transfers will take place; however, it is possible that under certain circumstances these activities might need to be conducted through Barrow or another location. The helicopter will fly a direct route between Wainwright and the drill rig, eight to ten times per week. Two helicopters will be stationed in Wainwright to allow these crew changes and resupplies to happen quickly and efficiently.

1.2.5 Refueling

Three refueling events per well are expected to be required for the drill rig, depending on the circumstances. The duration of a rig-fueling event will be approximately six hrs. All refueling operations will follow procedures approved by U.S. Coast Guard.

1.2.6 Oil Spill Probability and Spill Response

The remote possibility of a very large oil spill is not within the scope of specified activities for which COP seeks an IHA. However, COP has planned for the possibility of an oil spill, because a spill is not inconceivable. Thus, COP has submitted an *Oil Spill Response Plan* (OSRP) to the Bureau of Safety and Environmental Enforcement (BSEE), and we are awaiting a decision from BSEE on the submittal. COP has planned carefully to avoid the occurrence of a spill, and the chance of a spill occurring is very small. COP refers to the Lease Sale 193 Environmental Impact Statement (MMS 2007) and Supplemental Environmental Impact Statement (BOEM 2011) for discussion of the extremely low likelihood of an oil spill occurring. For more recent updates on occurrence rates for offshore oil spills from drilling platforms, including spills greater than or equal to 1,000 bbls and greater than or equal to 10,000 bbls we refer to the BOEM funded study of McMahon-Anders et al. (2012). Another BOEM directed study discusses most recent oil spill occurrence estimators and their variability for the Beaufort and Chukchi Seas for various sizes of spills as small as 50 bbls (Bercha 2011).

COP will have various measures and protocols in place that will be implemented to prevent oil releases from the wellbore, such as:

- Using information from previous wells in addition to recent data collected from 3D seismic and shallow hazard surveys, where applicable, to increase knowledge of the subsurface environment;
- Using skilled personnel and provide them with project-specific training. Implement frequent drills to keep personnel alert;
- Implementation of visual and automated procedures for the early detection of a spill
    - The drilling operation will be monitored continuously by Pit-Volume Totalizer equipment and visual monitoring of the mud circulating system.
    - Alarms will be sounded if there is a significant volume increase of drilling mud in the pits due to an influx into the wellbore.

  - Multiple walk-through inspections of the rig are performed every day by each crew to inspect and verify all control systems are functioning properly.
  - Mobile Offshore Drilling Unit's (MODU) Central Control & Radio Room monitors all safety aspects of the rig and is manned 24 hrs per day by qualified rig personnel.
  - Established emergency shutdown philosophies will be documented in the Contractor's Operations manuals and the crews will be trained accordingly. An emergency shutdown can be initiated manually by operators at the instrument/control panels or automatically under certain conditions.
- Maintaining a minimum of two barriers; the jack-up rig has the capability of utilizing advanced well control barriers:
  - Surface blow out preventer (BOP) located on the rig in a place that is easily accessible. This BOP can close in well on drill pipe or open hole.
  - Thick walled high strength riser designed to contain full well pressure.
  - Pre-Positioned Capping Device (PCD) will be installed above the wellhead on the sea floor. The PCD can keep the well isolated with pressure containment, even if the rig is moved off location. Can be triggered remotely from the drill rig or from support vessels.

Mechanical containment and recovery is COP's primary form of response. Actual spill response decisions depend on safety considerations, weather, and other environmental conditions. It is the discretion of the Incident Commander (IC) and Unified Command (UC) to select any sequence, response measure, or take as much time as necessary, to employ an effective response. COP's spill response fleet is mobile and capable of responding to incidents affecting open water, nearshore, and shoreline environments. Offshore spill response would be provided by the following vessels:

- Oil Spill Response Vessel (OSRV), the primary offshore oil spill response platform, located within about 5.5 mi of the drilling rig;
- Offshore Supply Vessel (OSV) , a vessel of opportunity response platform, located within about 5.5 mi of the drilling rig;
- Four workboats, two are located on the OSRV and two on the OSV; and
- One Oil Spill Tanker (OST), with a storage capacity of at least 520,000 barrels, also located within about 5.5 mi from the drilling rig.

Alaska Clean Seas personnel will be stationed on OSRV, OSV, and the drill rig. OSRV is the primary spill response vessel; it will also be used to support refueling of the jackup rig. In the event of an emergency, OSV will provide oil spill response and fast response craft capability near the ware vessel. During non-emergency operations, OSV will provide operational drill rig support, including standby support during vessel refueling operations. From their standby locations, it will take about 0.5 hour for the vessels to arrive at the rig.

Spill response support for nearshore operations will be located about 5.5 mi of the drill rig location and approximately 5 mi offshore of Wainwright. Nearshore spill response operations are provided by the following vessels:

- One Oil Spill Response Barge (OSRB) and tug with a storage capacity of 40,000 barrels;
- Four workboats, located on the OSRB;
- One large landing craft, located adjacent to the OSRB; and
- Four 32-foot shallow draft landing craft located on the large landing craft.

The OSRB and large landing craft are designed to carry and deploy a majority of the nearshore and onshore spill response assets. In the event of a spill, additional responders would be mobilized to man the OSRB, large landing craft, and other support vessels. From 5 mi offshore of Wainwright it will take about 24 hrs for the OSRB to arrive at the rig, assuming a travel speed of 5 knots and including notification time. However, because this barge is equipped primarily for nearshore response, it is unlikely to be needed offshore near the rig.

COP will maintain regular communications with the community of Wainwright regarding movements and anchoring locations of the nearshore spill response vessels during marine mammal subsistence hunting periods.

1.2.7 Drill Rig Demobilization

When drilling is completed, the jack-up rig will be demobilized and excess material transferred from the rig to supply vessels. The rig will then be jacked down and taken under tow by the AHST and OSVs to the load-out site, anticipated to be located south of the Devils Paw prospect area. The rig will remain in tow by the AHST until the HLV arrives. In case the drilling season ends earlier than anticipated, the rig may be towed to the alternate staging area and jacked up until the HLV arrives. In that situation, helicopters will be mobilized to Nome or the Red Dog Mine to support the rig as necessary.

Once the AHST has the jack-up rig under tow, all other support vessels would be dismissed. The AHST and OSVs would accompany the rig until it is loaded onto the HLV. Once the rig has been loaded onto the HLV, the AHST, supply vessels, and air support will be demobilized.

1.2.8 Vertical Seismic Profile Test

COP intends to conduct two or three Vertical Seismic Profile (VSP) data acquisition runs inside the wellbore to obtain high-resolution seismic images with detailed time-depth relationships and velocity profiles of the various geological layers. The VSP data can be used to help reprocess existing two-dimensional (2D) or 3D seismic data prior to drilling a potential future appraisal well in case oil or gas is discovered during the proposed exploration drilling.

The procedure of one VSP data acquisition run can be summarized as follows (Figure 2 provides a schematic of the layout):

- The source of energy for the VSP data acquisition, typically consisting of one or more airguns, will be lowered from the drilling platform or a vessel to a depth of approximately

10 ft (3 m) to 30 ft (10 m) below the water surface (depending on sea state). The total volume of the airgun(s) is not expected to exceed 760 cubic inches (in^3).

- A minimum of two geophones positioned 50 ft (15.2 m) apart will be placed at the end of a wireline cable which will be lowered into the wellbore to total depth (TD). Once TD has been reached the wireline cable will be pulled up and stopped at predefined depths (geophone stations). Data will be acquired by producing a series of sound pulses from the airgun(s) over a period of approximately one minute. The sound waves generated by the source and reflected from various geological layers will be recorded by the two geophones.

- After each one-minute airgun activity, the wireline cable with the geophones will be pulled up to a shallower position in the well after which the airgun(s) will again produce a series of sound pulses over a period of approximately one minute. This process will be repeated until data has been acquired at all pre-identified geophone stations.

Two or three VSP data acquisition runs will be conducted; the first run will take place upon reaching the bottom of the 17.5-inch (in) (44.5 centimeter [cm]) borehole at approximately 5,220 ft (1,590 m) below sea level (bsl), the second run upon reaching the bottom of the 13.5 and 8.5 in (34.2 and 21.5 cm) borehole at approximately 9,580 ft (2,920 m) bsl, and a possible third run upon reaching the bottom of the 6.5 in (16.5 cm) borehole at approximately 11,020 ft (33,590 m) bsl. If the integrity of the 8.5 in borehole allows drilling to 11,020 ft without the need for an extra casing a third VSP run might not be needed. The number of geophone stations for each of the three VSP data acquisition runs varies depending on the length of the wellbore to be surveyed. The time required to finish a VSP data acquisition run depends on the depth of the wellbore (resulting in longer time to lower and pull up the wire cable with geophones) and the number of stations (resulting in longer data acquisition time). The period between VSP data acquisition runs is about 7-10 days, depending on the drilling progress. The total amount of time that airguns are operating for the three runs that might be performed in a well is about 2 hrs, not including ramp up. In case a second well will be drilled, two or three additional VSP data acquisition runs might be conducted. Prior to and during the VSP data acquisition runs, all procedures outlined in the Marine Mammal Monitoring and Mitigation Plan (Attachment B of this IHA application) and stipulations in the forthcoming Incidental Harassment Authorization (IHA) will be followed, including any ramp-up and monitoring requirements.

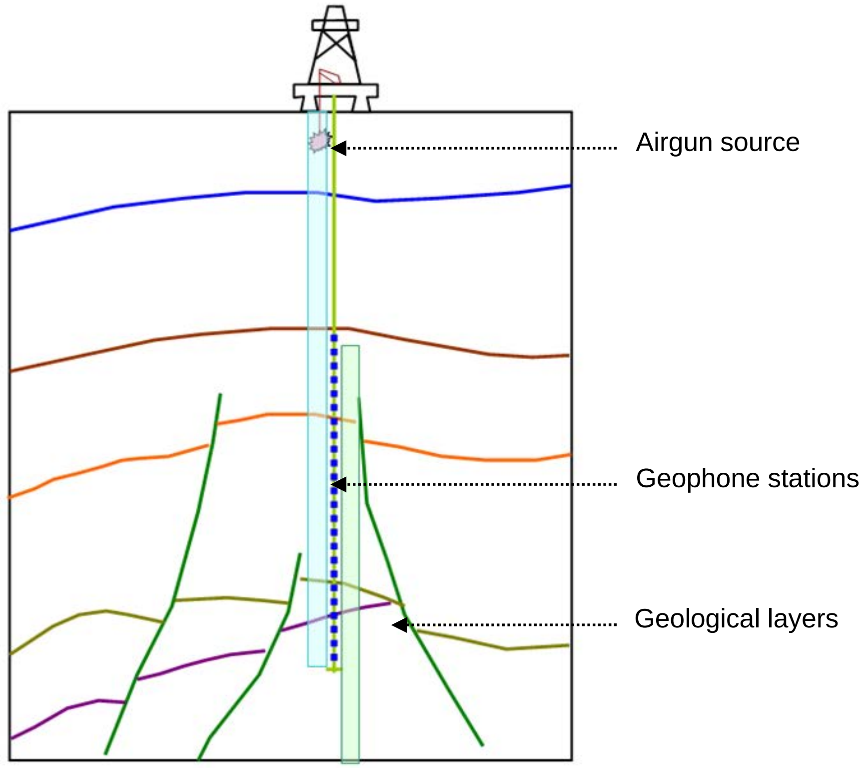


Figure 2 Schematic of Vertical Seismic Profile Data Acquisition

1.3 Vessel Movements

Various vessels will be involved in the drilling project, as summarized in Table 1. The vessels involved in supporting the drilling operations will remain at about 5.5 mi distance from the drill rig when they are not actively supporting the drilling operations. Several vessels will also be available for oil spill response purposes (Table 1). Most of these vessels are relatively small and will be located aboard a mother vessel, either the oil spill response barge or the landing craft. These vessels will not be deployed in the water, unless needed to respond to a spill or to conduct oil spill response exercises as directed by BSEE. The OSRV will also be on standby at 5.5 mi from the drill rig. In addition to the vessels required for the actual drilling operations, a science vessel will be conducting monitoring activities. Information on vessel mobilization dates and routes is provided in Section 2. Figure 3 provides an overview of the approximate locations of the vessels relative to the rig. The vessels will be located upwind from the rig and as such they could be moved to quadrant A, B, C, or D depending on prevailing the wind and currents.

Table 1 Summary of Number and Type of Vessels and Aircraft Involved in the 2014 Exploration Drilling Project [1].

Vessel Type	Number	Dimensions	Main activity	Frequency to Rig
Anchor Handling Supply Tug (AHST)	1	280 × 55 ft (85 ×17 m)	Rig mobilization & demobilization, firefighting capability, otherwise on standby near rig	--
Offshore Supply Vessels (OSV)	2	300 × 54 ft (76 ×16 m)	Rig tow	Min. 2 times per well
			Rig resupply, otherwise stationed near rig.	About 4.5 trips per week,
Ware Vessel	1	380 × 72 ft (116 × 22 m)	Rig resupply, otherwise on standby near rig	About 4 trips per week
Ice Management Vessel	1	350 × 80 ft (107 × 24 m)	On standby near rig. Ice observations within about 75 mi from rig.	--
Oil Spill Response Vessel (OSRV)	1	250 ft (76 m)	Rig refueling, otherwise on standby near rig	~3 times per well
			Oil spill exercises	TBD
Work Boats	4	32 ft (10 m)	Support oil spill response Aboard the OSRV and OSV	--
Oil Storage Tanker (OST)	1	600 ft (183 m)	On standby, except for oil spill exercise (or spill)	--
Nearshore Oil Spill Response Barge (OSRB) and Tug	1	300 ft (91.4 m)	On standby between drill site and 5 mi offshore of Wainwright	--
Boom boats	4	32 ft (10 m)	Support oil spill response. Aboard the OSRB or onshore at Wainwright	--
Large Landing Craft	1	~150 ft (~46 m)	Shuttling supplies between Wainwright and drill site. Otherwise on standby between drill site and 5 mi offshore of Wainwright	3 to 4 times per week
Small Landing Craft	4	32 ft (10 m)	Support oil spill response. Aboard the Large Landing Craft	--
Monitoring vessel	1	100 × 28 ft (30 × 8 m)	Discharge monitoring, Acoustic monitoring	Before, during, and after drilling
Helicopter	2	90 × 75 ft [rotors] (27.4m/ 22.9m)	Personnel and equipment transport between shore and drill rig	Consistently during operations
Fixed-wing airplane	1	84 × 9 × 90 ft [wingspan] (26 × 3 × 27 m)	Personnel and equipment transport between onshore locations	--

[1] No vessels have been contracted to date. However, COP will contract vessels with parameters similar to those described in this table. If contracted vessels differ significantly from those described, COP will submit an amendment to address these changes where required.

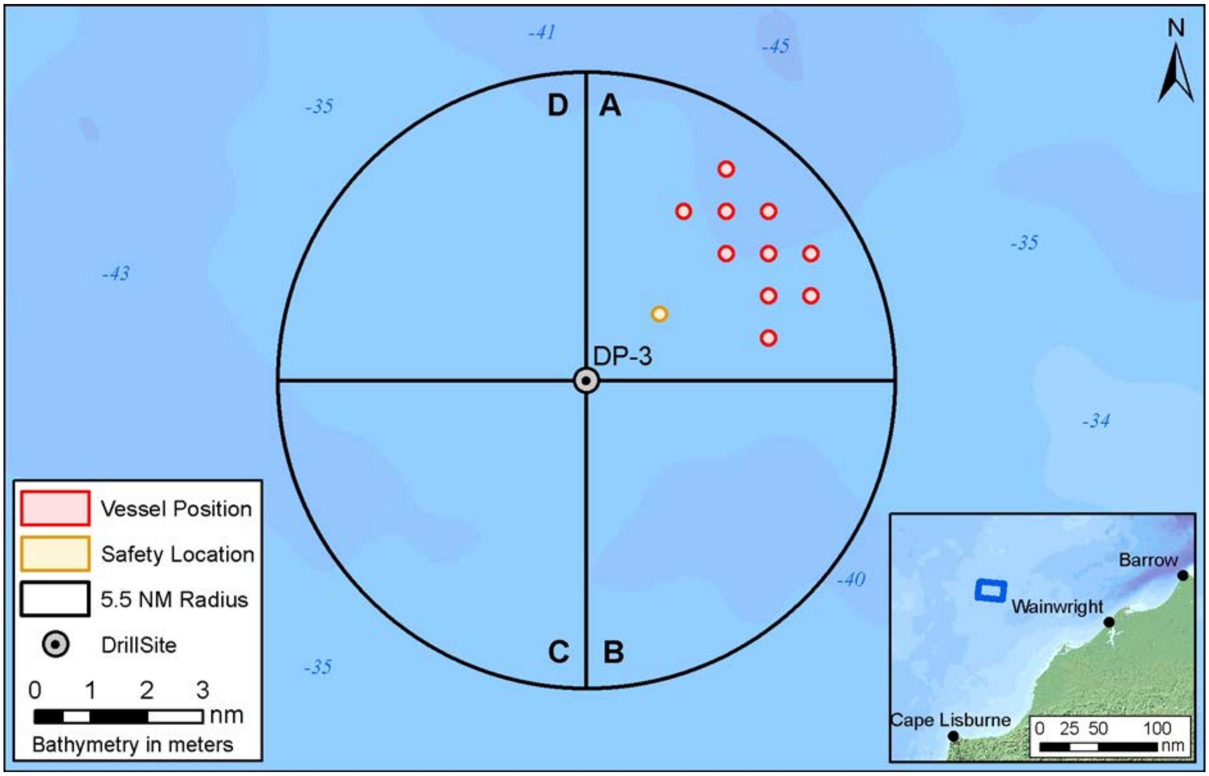


Figure 3. Vessel Positions Relative to the Drill Rig. A Project Vessel will be Present at the Safety Location during Refueling Events. Depending on Wind and Current the Vessels will be Located in Quadrant A, B, C, or D.

2. DATES, DURATION AND REGION OF ACTIVITY

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

ConocoPhillips seeks an IHA for exploration drilling activity in the Devils Paw prospect, Chukchi Sea, during the open water season in the summer of 2014. If time permits, COP plans to drill up to two wells in waters approximately 140 ft (43 m) deep. The coordinates of the possible drill sites are provided in Table 2. The project area is located approximately (~)120 mi (193 kilometers [km]) west of Wainwright, the village used for permanent infrastructure support for the project. Approximate distances from the project area to other villages along the Chukchi coast are ~200 mi (322 km) for Barrow, 90 mi (145 km) for Point Lay, and 175 mi (282 km) for Point Hope (Figure 1).

The HLV with the jack-up drill rig is expected to originate from Southeast Asia or the North Sea. Depending on its point of origin, mobilization to the Chukchi Sea will take between 22 and 60 days. Vessels are not expected to arrive at the lease sale area prior to July 1. The HLV will depart the area as soon as it has offloaded the rig. The AHST, OSVs and ware vessel will mobilize from the Gulf of Mexico around the first week of June and will be traveling north in close proximity to the HLV and jack-up rig. The ice-management vessel will be the first to mobilize to the drill site to provide information on ice conditions to the HLV and other vessels.The anticipated start and end dates of the mobilization, drilling operations, and demobilization are on or about June 15, 2014 and November 16, 2014 respectively, with actual activities in the lease sale area taking place roughly from July through October. These dates are dependent on regulatory approvals and ice and weather conditions and forecasts. Drilling of one well is expected to take approximately 40 days. Ice alert programs will be in place during the entire drilling operation. After the first Devils Paw well has been drilled, it will be plugged and abandoned. If there is enough time, as estimated by the ice monitoring system, COP will drill a second well which could take another 40 days. Relocation of the rig from the first to the second well will take approximately 24 to 48 hrs. The rig set-up process will be similar to the first well and ice monitoring will continue. Crew rotations, resupply of the rig, and the drilling process for the second well will also be similar to the first well. After the second well has been drilled, it will be plugged and abandoned and the rig will demobilize.

Table 2 Possible Drill Locations in the Devils Paw Prospect

Well Name	Water Depth (ft/m)	Block #	Longitude (DMS)[1]	Latitude (DMS)[1]	X (m)[2]	Y (m)[2]
DP-1D[3]	137/41.7	6123	-165° 14’56.208” W	70° 52’22.759” N	490896	7863250
DP-2D[3]	132/40.2	6074	-165° 02’46.065” W	70° 55’51.410” N	498469	7869249
DP-3	133/40.5	6023	-165° 14’24.970” W	70° 59’09.611” N	491264	7875846
DP-4	138/42.0	6220	-165° 37’35.246” W	70° 48’46.314” N	477027	7856354
DP-5	136/41.4	6073	-165° 13’51.464” W	70° 54’57.911” N	491572	7868054
DP-6	134/40.8	6123	-165° 08’54.367” W	70° 52’13.464” N	494571	7862950

Notes:
1 Geographic coordinates in degrees, minutes, seconds (DMS) WGS84
2 NAD83 UTM Zone 3N
3 DP-1 and DP-2 have deviated wellbores

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

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

Marine mammal species occurring in the Chukchi Sea that could be encountered in the Devils Paw prospect are classified as follows:

- *Order Cetacea*
  - Toothed whales or Odontocetes: e.g., beluga, killer whale, harbor porpoise
  - Baleen whales or Mysticetes: e.g., gray whale, bowhead whale, humpback whale
- *Order Pinnipedia*
  - Pinnipeds: e.g., ringed, spotted, bearded and ribbon seals, Pacific walrus
- *Order Carnivora*
  - Fissipeds: e.g., polar bear

Cetaceans and pinnipeds (except Pacific walrus) are the subjects of this IHA application to the National Marine Fisheries Service (NMFS). The Pacific walrus and polar bear are managed by the U.S. Fish and Wildlife Service (USFWS). An application for a letter of authorization (LOA) to allow incidental non-lethal harassment of Pacific walrus and polar bear will be submitted separately to the USFWS.

The marine mammal species under NMFS jurisdiction that are known to, or may, occur in the Chukchi Sea include eight cetacean species and four species of pinnipeds (Table 3). The narwhal (*Monodon monoceros*) most commonly occurs in the Arctic waters of West and East Greenland, and the eastern part of the Canadian Arctic archipelago (Reeves et al. 2002). Because there are only a few scattered historical records of narwhal in the Alaskan Arctic, it is highly unlikely that they would be encountered in the Chukchi Sea and/or the project area and this species is therefore not included in this IHA application.

Three of the eight cetacean species listed in Table 3 (the bowhead, humpback and fin whales) are listed as endangered under the Endangered Species Act (ESA). The bowhead whale is common in the Chukchi Sea, especially during the spring and fall migration periods. Although humpback and fin whales are uncommon in the northeastern Chukchi Sea, they are included in this application because there have been a few recent sightings and acoustic records of these species (Clarke et al. 2011, Delarue et al. 2011, Haley et al. 2010).

All four pinniped species are common in the northeastern Chukchi Sea. None of these species are listed under the ESA, however, NMFS determined that listing of the Alaskan stock of bearded and ringed seals as threatened under the ESA was warranted and issued proposed rules in the Federal Register in December 2010. The final rules are pending. NMFS initiated a new status review for the ribbon seal and a determination on whether listing is warranted remains pending.

In summary, the marine mammal species under NMFS jurisdiction most likely to occur in the Devils Paw prospect include five cetacean species (beluga, bowhead, gray, and killer whales, and harbor porpoises), and four pinniped species (ringed, spotted, bearded, and ribbon seals). The required information about the spatial and temporal distribution and abundance of these species (insofar as it is known) is included in Section 4.

Table 3 Habitat, Abundance and Conservation Status of Marine Mammals (under NMFS Jurisdiction) Likely to Occur in the Northeastern Chukchi Sea during the Open-water Season

Species	Abundance	Habitat	ESA[1]	IUCN[2]	CITES[3]
Odontocetes					
Beluga whale (*Delphinapterus leucas*) Beaufort Sea Stock Eastern Chukchi Sea Stock	 39,258[4] 3,710[5]	Offshore, coastal, ice edges	Not listed	NT	II
Killer whale (*Orcinus orca*)	Uncommon in the NE Chukchi Sea	Widely distributed	Not listed	DD	II
Harbor Porpoise (*Phocoena Phocoena*) Bering Sea Stock	 48,215[6]	Coastal, inland waters, shallow offshore waters	Not listed	LC	II
Mysticetes					
Bowhead whale (*Balaena mysticetus*) Bering-Chukchi-Beaufort Stock	 11,800[7]	Pack ice and coastal	Endangered	LC	I
Gray whale (*Eschrichtius robustus*) Eastern Pacific Population	 19,126[8]	Coastal, shoals	Not listed	LC	I
Minke whale (*Balaenoptera acutorostrata*)	Uncommon in the NE Chukchi Sea	Shelf, coastal	Not listed	LC	I
Fin whale (*Balaenoptera physalus*)	Uncommon in the NE Chukchi Sea	Slope, mostly pelagic	Endangered	EN	I
Humpback whale (*Megaptera novaeangliae*)	Uncommon in the NE Chukchi Sea	Shelf, coastal	Endangered	LC	I
Pinnipeds					
Bearded seal (*Erignathus barbatus*) Bering-Chukchi Sea Population Eastern Chukchi Sea Population	 250,000 - 300,000[9] 4,863[10]	Pack ice, open water	Final rule for listing pending	LC	-
Spotted seal (*Phoca largha*) Alaska Population Eastern and Central Bering Sea Population	 ~59,214[11] 101,568[12]	Pack ice, open water, coastal haul outs	Not listed	DD	-
Ringed seal *Phoca hispida*) Chukchi and Beaufort seas Population	 1,000,000[13]	Landfast and pack ice, open water	Final rule for listing pending	LC	-

Species	Abundance	Habitat	ESA[1]	IUCN[2]	CITES[3]
Ribbon seal (*Histriophoca fasciata*)	90,000 -100,000[14]	Pack ice, open water	In review for listing	DD	-

Notes:

1 U.S. Endangered Species Act.

2 International Union for Conservation of Nature (IUCN) 2011. IUCN Red List of Threatened Species. Version 2011.1 <www.iucnredlist.org>. Codes for IUCN classifications: EN = Endangered; NT = Near Threatened; LC = Least Concern; DD = Data Deficient. Category descriptions can be found at http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1#categories

3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004). Appendix I = Species threatened with extinction and CITES prohibits international trade, except when the purpose of the import is not commercial (e.g. scientific research); Appendix II = Species that may become threatened unless trade is closely controlled.

4 Beaufort Sea Stock. IWC 2000, Angliss and Allen 2009.

5 Eastern Chukchi Sea Stock. Angliss and Allen 2009.

6 Allen and Angliss (2010)

7 2004 Population estimate from photo-identification data (Koski et al. 2008).

8 North Pacific gray whale population (Laake et al. 2009).

9 Bering-Chukchi Sea population (Angliss and Allen 2009).

10 Eastern Chukchi Sea population (NMML, unpublished data).

11 Alaska population (Rugh et al. 1995, cited in Angliss and Allen 2009).

12 Eastern and Central Bering Sea (Boveng et al. 2009).

13 Estimated population of Chukchi and Beaufort seas (Kelly et al. 2010).

14 Burns, J.J. 1981a.

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 affected species or stocks of marine mammals likely to be affected by such activities

The sections below summarize the status and distribution of each species likely to occur in the area of the proposed drilling activity. The information is mainly based on the most recent sighting data from aerial surveys of the 2008-2010 Chukchi Offshore Monitoring in Drilling Area (COMIDA) program (Clarke et al. 2011) and from the 2008-2010 vessel-based marine mammal survey that formed an integral part of the ecosystem-based Chukchi Sea Environmental Studies Program (CSESP). This program was designed and initiated in 2008 by ConocoPhillips and co-funded by Shell and in 2010 also by Statoil (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). The CSESP also includes an acoustic component providing information on presence of marine mammals through detections of their vocalizations (Delarue et al. 2011). Information from various vessel-based surveys and a nearshore aerial survey that were part of monitoring and mitigation programs for seismic or shallow hazard surveys in the Devils Paw prospect or other prospects in the northeastern Chukchi Sea are also taken into account (Brueggeman et al. 2009a, Ireland et al. 2007, Haley et al. 2010, Reiser et al. 2010, Thomas et al. 2010).

The species expected to be encountered most often in the vicinity of the Devils Paw prospect during exploration drilling are the ringed, spotted, and bearded seals because of their habitat range and seasonal distribution. Cetacean species are relatively uncommon during the open water season. Of all marine mammal species under NMFS jurisdiction that are common and likely to occur in the lease area, the bowhead whale is currently the only ESA-listed species. Other ESA listed cetacean species, i.e., humpback and fin whale could also be encountered, however, occurrences of these species are considered uncommon for the northeastern Chukchi Sea.

4.1 Cetaceans – Odontocetes

4.1.1 Beluga Whale (*Delphinapterus leucas*)

The beluga whale is an arctic and subarctic species with a circumpolar distribution in the Northern Hemisphere. The beluga whale occurs mainly in seasonally ice-covered seas between 50ºN and 80ºN latitude (Reeves et al. 2002) and is closely associated with open leads and polynyas (Hazard 1988). Beluga whales can easily cover a distance of 1.2-1.8 mi (2-3 km) underwater making surface ice manageable, although the ice cannot be so thick as to prevent their forming breathing holes if needed (Harrison and Hall 1978).

There are five stocks of beluga whale in Alaska: the Beaufort Sea, Cook Inlet, Bristol Bay, eastern Bering Sea and eastern Chukchi Sea stocks (O'Corry-Crowe et al. 1997). The two stocks occurring in the Chukchi Sea that could be encountered during the planned activities are the Chukchi Sea stock and the Beaufort Sea stock which migrates through the Chukchi Sea to summering grounds in the Beaufort Sea. 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 2010). The Beaufort Sea stock population estimate is based on 1992 data (DeMaster 1995, Allen and Angliss 2010), while the Eastern Chukchi Sea stock estimate arises from survey effort in 1989-1991 (Allen and Angliss 2010). The Beaufort Sea stock is believed to be stable or increasing, while the eastern Chukchi Sea stock is considered to be stable (Allen and Angliss 2010).

In spring, the Beaufort and Chukchi Sea stocks of beluga whales migrate through coastal open leads from their winter grounds in the Bering Sea to the Arctic to reach their respective summer grounds in the Beaufort and Chukchi seas. The Beaufort Sea stock animals enter the Beaufort Sea in April or May, although some may arrive as early as March or as late as July (Braham et al. 1977, Ljungblad et al. 1984, Richardson et al. 1995b). Most of the Beaufort Sea stock enters the Mackenzie River estuary in the Canadian Beaufort Sea during July-August, and spend the rest of their summer offshore in the eastern Beaufort Sea, Amundsen Gulf and other northern waters (Davis and Evans 1982, Harwood et al. 1996, Richard et al. 2001). Beluga whales are not seen frequently in the central Beaufort Sea, although aerial surveys as part of seismic survey monitoring and mitigation plans did record some animals there in July 2008 (Christie et al. 2010). Beluga whales of the eastern Chukchi Sea stock are most common in Kotzebue Sound and near Kasegaluk Lagoon in early summer (Frost and Lowry 1990), where they usually arrive in late June or early July (Frost and Lowry, 1990; Huntington et al., 1999). The latest sightings of belugas near the lagoon usually occur in mid- to late July (Frost and Lowry, 1990; Huntington et al., 1999).

Beluga whales stay in shallow lagoons, such as Kasegaluk Lagoon in the Chukchi Sea and the Mackenzie River estuary in the Beaufort Sea, or other coastal areas to molt, feed, and calve and then move offshore later in the summer (after mid-July) to forage in the ice-packed deeper waters along and beyond the continental shelf (Finley 1982, Suydam et al. 2005, MMS 2007). Five of 23 beluga whales of the Chukchi stock 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 percent (%) pack ice at 79-80 degrees (°) north (N) latitude (Suydam et al. 2005), suggesting that a significant proportion of the population may be far-ranging during the mid- to late-summer period even leaving the Chukchi Sea region. In the fall, following a deepwater route along the continental shelf break or routes farther offshore, the Chukchi and Beaufort stocks both return to their wintering grounds in the Bering Sea (Allen and Angliss 2010). The Beaufort Sea stock returns to the Bering Sea via routes in the western Chukchi Sea. After spending the late summer in the northern Chukchi Sea, the eastern Chukchi stock travels west and then south along the eastern Chukchi Sea to return to their wintering grounds in the Bering (Suydam et al. 2005).

Beluga whales were observed during the COMIDA aerial surveys (2008-2010) in June, July, August, and October between Point Lay and Point Barrow shoreward from the lease areas. The November sightings were concentrated offshore of Point Hope (Clarke et al. 2011). Of a total of 64 sightings (1,567 whales), 73% occurred in July (Clarke et al. 2011). Peak beluga sightings were also observed during nearshore aerial surveys in the Chukchi Sea (~23 mi [37 km] from shore) in July 2006 and August 2007 as part of seismic survey marine mammal monitoring programs. These surveys recorded lowest sighting rates in September (Thomas et al. 2010). Five solitary beluga whales were observed offshore in 2006 during a vessel-based seismic marine mammal monitoring program (Ireland et al. 2007), but none were observed during similar programs from 2007 to 2009 (Brueggeman et al. 2009a, Haley et al. 2010, Reiser et al. 2010) and during the 2008-2010 CSESP surveys (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). Beluga vocalizations were recorded on eight of the 35 monitoring days within the Devils Paw prospect from late July to mid-October of 2008, but not in 2009 and 2010 (Clark 2010, Delarue et al. 2011).

Beluga whales are often seen migrating in groups of 100 to 600 animals (Braham and Krogman 1977) but permanent social units, such as nursing groups or family units, are much smaller (Brodie 1989). Beluga whales feed on a variety of fish and invertebrates, their diet varying by season and locale (Burns and Seaman 1985, Hazard 1988). In summer, beluga whales 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. Winter prey selection by beluga whales is virtually unknown.

4.1.2 Killer Whale (*Orcinus orca*)

Killer whales have the most widespread range of any cetacean, including all oceans and connecting seas (Leatherwood and Dahlheim 1978). They are very common in temperate waters but are also found frequenting the tropics as well as arctic waters. Killer whales are most often associated with coastal areas but they also occur in deep water (Dahlheim and Heyning 1999). The greatest abundance of killer whales occurs within 479 mi (800 km) of major continents (Mitchell 1975) and in areas with abundant prey. There are three ecotypes associated with killer whales: residents, transients, and offshore. Although these ecotypes may overlap in their use of habitat, they do not appear to interact with each other. The resident ecotype is, as the name implies, primarily resident year-round in a particular area and live in large pods of related individuals, while transient killer whales range more widely, occur in small groups (fewer than 10 whales) and have no defined home range. Offshore killer whales have the largest geographic range of any killer whale community and typically occur in groups of 20-75 animals. Studies indicate that there are genetic, behavioral, ecological and morphological differences between the ecotypes (Ford and Fisher 1982, Baird and Stacey 1988, Baird et al. 1992, Hoelzel et al. 1998, 2002, Barrett-Lennard 2000).

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 2010). Killer whales observed in the eastern Chukchi Sea are most likely from the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock (MMS 2008) which has a minimum of 314 whales and are frequently found near coastlines (Allen and Angliss 2010). They are not reported as occurring on a regular basis. However, they are seen periodically in summer months (Allen and Angliss 2010). In 2012 several killer whales were recorded in the Chukchi Sea, among which a pod of about 25-30 animals traveling close to the ice edge (pers. comm. Aerts). Native Alaska seal hunters in Barrow see orcas every summer (Craig George, Anchorage Daily News, September 10, 2012), so it is not uncommon to see killer whales in the Chukchi Sea.

Small numbers of killer whales have been documented in the Chukchi Sea within or in close proximity of the Devils Paw prospect in 1990 (Brueggeman et al. 1990). More recently, up to nine killer whales in two pods, including one to three juveniles in each pod were recorded in the Devils Paw prospect during the 2008 CSESP marine mammal survey (Brueggeman et al. 2009b), but none during the 2009 and 2010 CSESP research cruises (Brueggeman et al. 2010, Aerts et al. 2011). The acoustic recorders, however, detected killer whale vocalizations in the prospect on several days during the summer period of 2009, but none in 2010 (Delarue et al. 2011). One group of two killer whales was observed during seismic survey marine mammal monitoring programs in 2006 and one killer whale in 2007. No killer whales were observed during other industry survey programs in 2008 and 2009 (Brueggeman et al. 2009a, Haley et al. 2010, Reiser et al. 2010) or during the COMIDA aerial surveys in 2008-2010 (Clarke et al. 2011) and 2011 (Clarke et al. 2012). In conclusion, it is possible to encounter killer whales in the Devils Paw prospect, but not frequent and not likely in large numbers.

4.1.3 Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is a small odontocete that inhabits shallow, temperate, subarctic, and arctic coastal waters in the Northern Hemisphere (Read 1999). Harbor porpoises are found mainly in shelf areas where they can dive to depths of at least 722 ft (220 m). They feed on small schooling fish (Read 1999) and can stay submerged for more than 5 minutes (min) (Harwood and Wilson 2001).

Harbor porpoises typically occur in small groups that consist of pairs or groups of 5-10 individuals (Leatherwood et al. 1976). Although the precise stock structure of the harbor porpoise is yet to be determined, three stocks have been identified for management purposes in Alaska: the Bering Sea, Gulf of Alaska and Southeast Alaska stocks (Allen and Angliss 2010). Based on aerial surveys conducted in 1999, the Bering Sea population was estimated at 48,215 animals, although this estimate is likely conservative because the surveyed area did not include known harbor porpoise ranges near the Pribilof Islands, or waters north of Cape Newenhan (~55°N latitude; Allen and Angliss 2010).

Harbor porpoises were sighted in small numbers in the Devils Paw prospect during the CSESP marine mammal surveys, with three sightings of seven individuals in 2008 and one sighting of three individuals in 2010 (Brueggeman et al. 2009b, Aerts et al. 2011). During the 2009 CSESP marine mammal survey, two sightings of three animals were recorded near the coast (Brueggeman et al. 2010). Vessel-based seismic and shallow hazard marine mammal monitoring programs in the Chukchi Sea from 2006 to 2009 also recorded harbor porpoises within or in close proximity to the Devils Paw prospect (Haley et al. 2010, Ireland et al. 2007, Reiser et al. 2010). Although in small numbers, harbor porpoises have been observed frequently in the proximity of the Devils prospect.

4.2 Cetaceans – Mysticetes

4.2.1 Bowhead Whale (*Balaena mysticetus*)

Bowhead whales only occur in the northern hemisphere at high latitudes and have a somewhat circumpolar distribution (Reeves 1980). They are found in the Arctic (Bering, Chukchi and Beaufort seas), the Canadian Arctic and West Greenland (Baffin Bay, Davis Strait, and Hudson Bay), the Okhotsk Sea (eastern Russia), and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. Five stocks are recognized for management purposes. Of the five stocks of bowhead whales recognized by the International Whaling Commission (IWC), the Western Arctic stock or Bering-Chukchi-Beaufort (BCB) stock seasonally inhabits the Chukchi Sea and is most likely to be found in the planned drilling activities area. The BCB stock has the largest population of the five stocks, accounting for about 90% of the species' world population. These whales winter in the Bering Sea and migrate through the Bering Strait, Chukchi Sea and Alaskan Beaufort Sea to their summer feeding habitat in the Canadian Beaufort Sea. Spring migration through the Chukchi and the western Beaufort Sea occurs through offshore ice leads, generally from March through mid-June (Braham et al. 1984, Moore and Reeves 1993). In the fall, they return through the Beaufort Sea to their wintering grounds in the central and western Bering Sea (Moore and Reeves 1993). Satellite tracking data indicate that some bowhead whales continue migrating west past Barrow and through the Chukchi Sea to Russian waters before turning south toward the Bering Sea (Quakenbush 2007, Quakenbush et al. 2010).

Estimates of bowhead whales in the Bering, Chukchi and Beaufort Seas, before they were overharvested by commercial whaling, were between 10,400-23,000 whales. Commercial whaling decreased the population size to approximately 3,000 whales (Woodby and Botkin 1993). Until the early 1990s, the population was believed to be increasing at a rate of ~ 3.2% per year (Zeh et al. 1996) despite annual subsistence harvests of 14–74 bowheads from 1973 to 1997 (Suydam et al. 1995). A census in 2001, yielded an estimated annual population growth rate of 3.4% (95% CI 1.7–5%) from 1978 to 2001 and a population size (in 2001) of ~10,470 animals (George et al. 2004, revised to 10,545 by Zeh and Punt [2005]). A population estimate from photo identification data collected in 2004 indicated 11,800 animals (Koski et al. 2008), which further supports the estimated 3.4% population growth rate. Assuming a continuing annual population growth of 3.4%, the 2010 bowhead population may number around 14,200 animals. The increase in population estimates between the late 1970s to the early 1990s is believed to be a result of bowhead whale population growth as well as improvements made to census techniques.

Although recovering well following its decline, the bowhead whale is currently still listed as endangered under the ESA, and depleted by the Marine Mammal Protection Act (MMPA) (Allen and Angliss 2010). It is also an Alaska Species of Concern with the Alaska Department of Fish and Game (ADF&G). The Alaska Eskimo Whaling Commission (AEWC) has co-managed this stock with the U.S. government since the 1980s.

The Bering-Chukchi-Beaufort population migrates north using nearshore leads in the Chukchi Sea from March through mid-June (Braham et al. 1984, Moore and Reeves 1993), although small numbers may remain in the Bering and Chukchi seas during summer (Rugh et al. 2003, Sekiguchi 2007, Moore et al. 2010). Clarke et al. (2011) reports 65 sightings of 112 bowhead whales (on- and off-effort) during the COMIDA aerial surveys in the Chukchi Sea for the period 2008-2010, with the greatest number of sightings in October and the fewest in August and November (Clarke et al. 2011). Most sightings were recorded in proximity of Barrow, but also offshore of Point Franklin within or close to the lease areas. A total of 32 bowhead sightings of 33 animals were reported during nearshore aerial surveys in the northeastern Chukchi Sea from 2006 to 2008 (Thomas et al. 2010), with most sightings in 2007. All these sightings were recorded in the northern portion of the study area north of 70ºN latitude.

In the fall, bowhead whales return through the Beaufort Sea to their wintering grounds in the central and western Bering Sea (Moore and Reeves 1993). Westbound bowheads typically reach the Barrow area in mid-September, and remain there until late October (e.g., Brower 1996). Recent satellite tagging data from ADF&G (Quakenbush et al. 2010) indicates that most bowhead whales migrating in September and October transit across the northern Chukchi Sea to the Chukotka coast before heading south in the Bering Sea. A similar pattern is also shown by the acoustic vocalizations (Delarue et al. 2011).

There were 40 sightings of 59 bowhead whales observed during the vessel-based 2008-2010 CSESP marine mammal surveys (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). None of these bowhead whales were sighted in the Devils Paw prospect, which, in part, can be attributed to the survey timing. More bowhead whales were sighted in 2010 than in the previous two years, with all sightings in early October just before the end of the survey period, except for one sighting of two animals 17 September 2010. The data from 2011, however, showed 13 sightings of 17 bowheads in August, with six of these sightings in the Devils Paw Prospect (Aerts, personal communication). Vocalizations of bowheads occurred on most days during the summer and fall, with the highest detections in late September and October (Clark 2010, Delarue et al. 2011). Peak monthly bowhead sighting rates in the northeastern Chukchi Sea have been highest from late September to November and lowest in July to early September. The most likely time of year for bowhead whales to be passing through the project area is in September and October during the fall migration through the Chukchi Sea.

4.2.2 Gray Whale (*Eschrichtius robustus*)

Gray whales 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. There are currently two populations of gray whales in the North Pacific Ocean: the eastern North Pacific which lives along the west coast of America and the western North Pacific, which lives along the coast of eastern Asia (Rice et al. 1984, Swartz et al. 2006) and summers near Sakhalin Island, Russia. The western North Pacific population occurs far from the project area and is not discussed further. The eastern North Pacific population of gray whales occurs in the project area during the summer and fall (MMS 2008) and is described in more detail here.

Though populations have fluctuated greatly, the eastern Pacific gray whale population has recovered significantly from commercial whaling under protection of the Marine Mammal Protection Act (and ESA until 1994). In 1997, Rugh et al. (2005) estimated the population at 29,758 ±3,122; in winter 2001/02, the estimate was 18,178 ±1,780. The population estimate increased during winter 2006/07 to 20,110 ±1,766 (Rugh et al. 2008). A re-evaluation of the data using an improved method for treatment of error in pod size and detection probability estimation showed that abundance estimates between 1967 and 1987 were generally larger (-2.5% to 21%) than previous estimates. This was the opposite for abundance estimates between 1992 and 2006 that were generally smaller (-4.9% to -29%) than previously estimated. The re-evaluated 2006/07 population was estimated at 19,126 (Laake et al. 2009). Another modeling analysis estimated the effect of the 1999-2000 mortality event on the gray whale population growth (Punt and Wade 2010). They found that 15.3% of the non-calf population died in each of the years of the mortality event, compared to about 2% in a normal year (Punt and Wade 2010). The most recent abundance estimate from 2006/07 suggests the population has nearly increased back up to the level seen in the 1990s before the mortality event in 1999 and 2000 (Punt and Wade 2010).

Eastern Pacific gray whales calve in the protected waters of the Gulf of California, Mexico from January to April (Swartz and Jones 1981, Jones and Swartz 1984). At the end of the calving season, most of these gray whales migrate ~4,971 mi (8,000 km), generally along the west coast of North America, to their main summer feeding grounds in the northern Bering and Chukchi seas (Tomilin 1957, Rice and Wolman 1971, Braham 1984, Nerini 1984, Moore et al. 2003, Bluhm et al. 2007). Most gray whales begin to migrate south in November with breeding and conception occurring in early December (Rice and Wolman 1971).

Gray whales summering grounds historically concentrated in the northern Bering Sea, particularly off St. Lawrence Island in the Chirikov Basin (Moore et al. 2000a), and in the southern Chukchi Sea. The northeastern-most recurring feeding area for gray whales is located in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989). Recent data suggests that use of the Chirikov Basin by gray whales has decreased, possibly due to combined effects of changing currents which have resulted in secondary productivity dominated by lower-quality food sources. Data showing a 50% decline in ampeliscid amphipod production in the Chirikov Basin from the 1980s to 2002–2003 and that as little as 3–6% of the current gray whale population could consume 10–20% of the ampeliscid amphipod annual production in the basin (Coyle et al. 2007). These data support hypotheses that changes in food production may cause changes in gray whale distribution and that gray whales may be approaching or have surpassed the current carrying capacity of their summer feeding areas.

During the summer, gray whales feed in the Chukchi Sea primarily between Cape Lisburne and Point Barrow, most often in shallow, coastal shoal habitat (Moore et al. 2000b). Gray whales are often found clustered near shore at Point Hope and between Icy Cape and Point Barrow, as well as in offshore waters northwest of Point Barrow at Hanna Shoal and southwest of Point Hope in autumn. Gray whales were commonly observed during the COMIDA aerial surveys (226, 390 and 266 animals sighted in 2008, 2009 and 2010, respectively), mostly nearshore (Clarke et al. 2011). Thomas et al. (2009) also reported gray whales during nearshore aerial surveys of the northeastern Chukchi Sea. The CSESP vessel-based marine mammal surveys reported a few gray whales offshore within the study areas compared to sightings nearshore of Wainwright (Brueggeman et al. 2009b, 2010, Aerts et al. 2011).

4.2.3 Minke Whale (*Balaenoptera acutorostrata*)

Minke whales have a very broad global distribution at ice-free latitudes (Stewart and Leatherwood 1985), and also occur in some marginal ice areas (Leatherwood et al. 1982). They typically feed at high latitudes and move south during winter. The species is known to move further into ice fields than any other rorqual (Nowak 1999). Allen and Angliss (2010) recognize two minke whale stocks in U.S. waters: the Alaska stock and the California/Oregon/Washington stock. According to Allen and Angliss (2010), the minke whale is relatively common in the Bering and Chukchi seas, although population estimates for stocks occurring in Alaska are currently unavailable. Provisional estimates of minke whale abundance based on surveys in 1999 and 2000 are 810 and 1,003 whales in the central-eastern and south-eastern Bering Sea, respectively. These estimates only covered part of the Alaska stock range, and have not been corrected for animals that may have been submerged or otherwise missed during the surveys. Most minke whale sightings in the central-eastern Bering Sea occurred in waters 328-656 ft (100-200 m) deep (Moore et al. 2000c) while sightings in the southeastern Bering Sea were associated with the 328 ft (100 m) contour (Moore et al. 2002). Minke whales are not listed as depleted under the MMPA and are not listed under the ESA (Allen and Angliss 2010).

The range of minke whales might be expanding into the northern Chukchi Sea. One minke whale was sighted each year during the 2008 and 2009 CSESP marine mammal surveys (Brueggeman et al. 2009b, 2010), but none in 2010 (Aerts et al. 2011). Minke whale sightings were also recorded each year from 2006 to 2008 in the northeastern Chukchi Sea during vessel-based surveys as part of marine mammal mitigation and monitoring programs during seismic or shallow hazard surveys (Ireland et al. 2007, Haley et al. 2010). No minke whales were observed during the aerial survey in the COMIDA area from 1982-1991 and from 2008-2010 (Clarke et al. 2011), however five confirmed sightings of six minke whales (and some “probable” minke whale sightings) were recorded during the 2011 survey, including what is likely the farthest north confirmed minke whale sighting recorded in the Chukchi Sea (Clarke et al. 2012). So, although minke whales are not common in the northeastern Chukchi Sea, they could be encountered in the Devils Paw prospect during the summer and early fall.

4.2.4 Fin Whale (*Balaenoptera physalus*)

Fin whales are widely distributed in all the world's oceans (Gambell 1985), but typically occur in temperate and polar latitudes and less frequently in the tropics (Mizroch et al. 1984, Reeves et al. 2002). Fin whales feed in northern latitudes during the summer where their prey includes plankton as well as schooling pelagic fish, such as herring, sandlance, and capelin (Jonsgård

1966a,b, Reeves et al. 2002), returning to warm temperate and tropical regions in the fall. Although three stocks of fin whales are recognized in the U.S., only the Northeast Pacific stock is thought to occur in Alaskan waters; this stock summers from the Chukchi Sea to California (Gambell 1985). A population abundance estimate for the Northeast Pacific stock of fin whales is currently unavailable (Allen and Angliss 2010) but population estimates for the entire North Pacific population range from 14,620 to 18,630. Provisional estimates of fin whale abundance in the central-eastern and south-eastern Bering Sea are 3,368 and 683, respectively. No estimates for fin whale abundance during the summer in the Chukchi Sea are available.

Sightings of fin whales in the northeastern Chukchi Sea are rare. During aerial surveys from 1979 to 1987 (Ljungblad et al. 1982, 1988), fin whales were seen once just north of the Bering Strait. One fin whale was also observed during the COMIDA aerial survey in July 2008, but none were sighted in the same area from 1982-1991 (Clarke et al. 2011). Two sightings of four fin whales were recorded in 2008 in the northeastern Chukchi Sea during 2006-2008 marine mammal monitoring programs from seismic and shallow hazard survey vessels (Haley et al. 2010). None were sighted during the 2008, 2009 and 2010 CSESP vessel-based surveys (Brueggeman et al. 2009b, 2010, Aerts et al. 2011), however, fin whale vocalizations were detected by acoustic recorders about 60 mi (100 km) northeast of Cape Lisburne and Point Lay and about 30 mi (50 km) west of Devils Paw prospect (Delarue et al. 2011).

The fin whale is listed as endangered under the ESA and by IUCN and is classified as a strategic stock by NMFS (Table 1). Fin whales could be encountered in low numbers during the planned exploration drilling in the Chukchi Sea.

4.2.5 Humpback Whale (*Megaptera novaeangliae*)

Humpback whales are widely distributed in major oceans around the world, wintering in tropical and sub-tropical water where breeding and calving occur and migrating north to higher latitudes during the summer to feed. The main food source for humpback whales consists of euphausiids, copepods, and small schooling fish, notably herring, capelin and sandlance (Reeves et al. 2002). The range of the humpback whale in the North Pacific extends through the Bering Sea and into the southern Chukchi Sea (Allen and Angliss 2010).

Humpback whales were hunted extensively during the 20th century and worldwide populations were thought to be reduced to approximately 10% of their original numbers. In 1965, the IWC banned commercial hunting of humpback whales in the Pacific Ocean and in 1973 humpbacks were listed as endangered under the ESA and depleted under the MMPA. Since the ban, most humpback whale populations appear to be recovering.

According to Allen and Angliss (2010), at least three humpback whale populations have been identified in the North Pacific Ocean: the eastern North Pacific (also called California/Oregon/Washington - Mexico stock), central North Pacific, and western North Pacific stocks. The stock structure of humpback whales is defined based on feeding areas (Allen and Angliss 2010). Humpback whales observed in the project area are most likely from the western North Pacific Stock as their feeding grounds are located in the Aleutian Islands, the Bering Sea and Russia, although several studies indicate there is some overlap between the central and western North Pacific stocks at their summer feeding grounds (Mizroch et al. 2004, Waite et al. 1999, Witteveen et al. 2004), there is also overlap between stocks on their wintering grounds (Allen and Angliss 2010). Current population trends for this stock are unavailable (MMS 2008), however abundance estimates for the Bering Sea and Aleutian Islands ranges from 6,000-

14,000 (Allen and Angliss 2010). Moore et al. (2000c) estimated humpback whale abundance in the central Bering Sea at 1,175 animals and Moore et al. (2002) provided an estimate of 102 animals for the eastern Bering Sea in 2000. Abundance estimates for the Aleutian Islands, Bering Sea, and Gulf of Alaska combined range from 4,000 to 19,000 animals (Zerbini et al. 2006, Allen and Angliss 2010).

Humpback whale sightings in the Bering Sea have been recorded southwest of St. Lawrence Island, the southeastern Bering Sea, and north of the central Aleutian Islands (Moore et al. 2002, Allen and Angliss 2010). Recently there have been occasional sightings of humpback whales in the northeastern Chukchi Sea. One humpback was observed in July 2009 during the COMIDA aerial surveys; no humpback whales were observed during COMIDA surveys in 2008 or 2010 (Clarke et al. 2011). Three sightings of five humpback whales were sighted in 2007 and one animal in 2008 during marine mammal surveys conducted as part of seismic survey mitigation and monitoring plans (Haley et al. 2010). No humpback whales were observed during the 2008-2010 CSESP marine mammal surveys (Brueggeman et al. 2009b, 2010, Aerts et al. 2011) Because the Chukchi Sea is the northernmost extent of their range (Allen and Angliss 2010) and only few humpback whales have been sighted in the area in the past several years, it is considered unlikely that humpback whales will be encountered in the Devils prospect area during exploration drilling activities.

4.3 Pinnipeds

4.3.1 Bearded Seal (*Erignathus barbatus*)

Bearded seals have a circumpolar distribution and are strongly ice-associated. In Alaskan waters, bearded seals occur over the continental shelf waters of the Bering, Chukchi, and Beaufort seas (Burns 1981b) from nearshore waters out at least as far as the shelf break (Allen and Angliss 2010). Surveys along the Alaskan coast indicate bearded seals prefer areas of 70% to 90% sea ice coverage (Allen and Angliss 2010). They generally inhabit areas of shallow water (less than 200m) that are seasonally ice covered (Cameron et al. 2009, Allen and Angliss 2010).

Bearded seals migrate seasonally with the advance and retreat of sea-ice and water depth (Kelly 1988). As the ice recedes in the spring, bearded seals overwintering in the Bering Sea migrate through the Bering Strait (mid-April to June), and summer either along the margin of the multi-year ice in the Chukchi Sea or in nearshore areas of the central and western Beaufort Sea. Bearded seals were also present throughout the Chukchi Sea in the winter of 2008 and 2009 as is apparent from acoustic detections recorded as part of the CSESP (Julien Delarue, personal communication).

Bearded seals breed in the spring. Pupping takes place on top of the ice from late-March through May, primarily in the Bering and Chukchi seas, although some pupping takes place on moving pack ice in the Beaufort Sea. These seals do not form herds, although loose aggregations of animals may occur. The Alaska stock of bearded seals is believed to be greater than 155,000 (Beringia DPS, NMFS 2010a) and may be as large as 250,000-300,000 (Popov 1976, Burns 1981b, MMS 1996), but there is no reliable estimate of bearded seal abundance in the Chukchi Sea (Allen and Angliss 2010, Cameron et al. 2010). Crude estimates based on observed densities in the U.S. portion of the Chukchi Sea provide uncorrected estimates of 13,600 bearded seals (Cameron et al. 2010); the Beringia DPS data estimated 63,200 bearded seals in the eastern Bering Sea (Ver Hoef et al. 2010) and the total Bering Sea population may be twice that (Cameron et al. 2010). The Alaska stock of bearded seals, part of the Beringia distinct population segment, has been proposed by NMFS for listing as threatened under the ESA (NMFS 2010a).

Bearded seals have been observed regularly in the Devils Paw prospect. During the 2008 to 2010 CSESP marine mammal surveys the number of bearded seals observed in the Devils Paw prospect was 37 in 2008, 7 in 2009, and 8 in 2010. In the Burger area (about 25 mi [40 km] northeast of Devils Paw), the numbers of bearded seals were 62, 22, and 41 for 2008, 2009 and 2010, respectively (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). Average bearded seal density in the Devils Paw prospect, taking into account probability of detection, was 0.014 seals/square kilometers (km^2). Maximum density of 0.025 seals/km^2 was observed in 2008. During aerial and vessel-based marine mammal surveys from 1989 through 1991 around five oil and gas prospects in the Chukchi Sea, 258 sightings of bearded seals were recorded in fragmented ice patches (Brueggeman et al. 1990, 1991, 1992). Bearded seals were also sighted during the COMIDA aerials surveys conducted in the Chukchi Sea (Clarke et al. 2011), but most sightings were outside the Devils Paw prospect. Bearded seals were regularly observed during a vessel-based marine mammal monitoring program from seismic and shallow hazard survey vessels that included the Devils Paw prospect (Ireland et al. 2007). Bearded seals are likely to be encountered during exploration drilling but the numbers in the Devils Paw prospect are expected to be relatively small, since drilling activities will occur only if there is no sea ice present in the area.

4.3.2 Spotted Seal (*Phoca largha*)

The spotted seal is found from the Beaufort Sea to the Sea of Japan and is most numerous in the Bering and Chukchi seas (Quakenbush 1988). The population of spotted seals worldwide has been estimated between 370,000 and 420,000 (Bigg 1981) with the Bering Sea population, including Russian animals, estimated at 200,000-250,000 (Bigg 1981). A reliable estimate of the entire Alaskan stock is currently not known (Allen and Angliss 2010), but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997).

Pupping occurs in the Bering Sea wintering areas in early spring (March and April), followed by mating and molt in May and June (Quakenbush 1988). The seals are strongly ice-associated during this time. During the summer, spotted seals are found in Alaska from Bristol Bay through western Alaska to the Chukchi and Beaufort seas where they haul out on land for at least part of the time. Spotted seals are commonly seen in bays, lagoons and estuaries, but also range far offshore as far north as 69-72°N latitude; during summer they are rarely seen on pack ice unless the ice is close to shore. Kasegaluk Lagoon and Icy Cape are important areas for spotted seals in the Chukchi sea, as they haul out in this area from mid-July until freeze up in late October or November. In October, spotted seals begin their migration south into the Bering Sea (Lowry et al. 1998) where the animals overwinter.

Satellite transmitters placed on four spotted seals in Kasegaluk Lagoon resulted in estimates that only 6.8% of seals were hauled out (Lowry et al. 1998). Based on an actual minimum count of 4,145 hauled out seals, Allen and Angliss (2010) estimated the Alaskan population at 59,214 animals. Because of the concern about the future of ice seals due to receding ice conditions and associated potential habitat loss, NMFS conducted a status review of the spotted seal. Preliminary analyses from 2007 and 2008 survey data in the central and eastern Bering Sea provided a provisional abundance estimate of 101,568 (SE = 17,869) spotted seals in that area (Boveng et al. 2009). Based on this status review, NMFS determined not to list the Bering Sea stock of spotted seals under the ESA, because they are currently not in danger of extinction or likely to become endangered in the foreseeable future (NMFS 2009).

Spotted seals were observed in the Devils Paw prospect during the 2008 to 2010 CSESP vessel-based surveys (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). In most cases, however, it was difficult to distinguish between spotted and ringed seals, so most sightings are combined spotted/ringed seal observations. Average spotted seal density in the Devils Paw prospect, taking into account probability of detection, was 0.024 seals/km^2. Maximum density of 0.036 seals/km^2 was observed in 2008. Spotted seals were also observed during nearshore aerial and offshore vessel-based surveys conducted as part of seismic survey marine mammal monitoring programs (Haley et al. 2010, Ireland et al. 2007, Reiser et al. 2010, Thomas et al. 2010). During the proposed drilling operations, spotted seals are expected to be encountered in the area.

4.3.3 Ringed Seal (*Phoca hispida*)

Ringed seals have a circumpolar distribution (King 1983) and are year-round residents in the Beaufort, Bering and Chukchi seas (King 1983, Allen and Angliss 2010). Results from satellite tagging studies show that mainly adult ringed seals remain in the Chukchi and Beaufort Seas during winter. Subadults, unconstrained by the need to maintain territories that contain stable breeding/pupping habitat, moved south to the Bering Sea ice edge, where there are better feeding opportunities, lower energetic costs (no need for breathing hole maintenance), and less exposure to predation (Crawford et al. 2012). Ringed seals are closely associated with ice; prefer large floes (greater than [>]157 ft [>48 m] in diameter) and can often be found in areas with ice coverage >90% (Allen and Angliss 2010). Preferring to winter and breed on nearshore stable landfast ice, they are sometimes found at low densities in offshore pack ice. Hauling out on disintegrating landfast ice in May and June, the ringed seals then follow the receding ice edge north (Allen and Angliss 2010). They maintain breathing holes throughout the winter in ice up to 6 ft (1.8m) thick and dig multiple haul-out shelters and nursery lairs beneath the snow (Kelly 1988). During March and April, female seals build snow lairs along pressure ridges or under snowdrifts on landfast or drifting icepack, where they give birth to a single pup which is then nursed for 5-8 weeks (Smith 1973, Hammill et al. 1991, Lydersen and Hammill 1993).

There is currently no complete population estimate available for the entire Alaskan stock (Allen and Angliss 2010). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1-1.5 million (Frost 1985) to 3.3-3.6 million (Frost et al. 1988). Based on aerial surveys flown in 1999 and 2000 along the Chukchi sea coast from Shishmaref to Barrow (Bengston et al. 2005) the ringed seal population in that area was estimated at approximately 249,000 animals in the shorefast ice and 1-1.5 million including seals in the pack-ice habitat (NMFS 2010b). The highest densities of ringed seals were found in coastal waters south of Kivalina and near Kotzebue Sound (Bengtson et al. 2005). The Alaska stock, part of the Arctic subspecies of ringed seal, has been proposed for listing as threatened under the ESA (NMFS 2010b).

Observations of ringed seals have been recorded in high numbers within and in the vicinity of the Devils Paw prospect during the CSESP surveys; however, because ringed and spotted seals are difficult to distinguish, observations of these two seal species were often lumped together (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). Average ringed seal density in the Devils Paw prospect, taking into account probability of detection, was 0.052 seals/km^2. Maximum density of 0.126 seals/km^2 was observed in 2008. Ringed seals were also the most commonly observed species in the northeastern Chukchi Sea during marine mammal surveys as part of seismic and shallow hazard monitoring and mitigation programs (Ireland et al. 2007, Brueggeman et al. 2009a, Haley et al. 2010, Reiser et al. 2010). The ringed seal will likely be the most abundant marine mammal species encountered in the area of the proposed exploration drilling activities.

4.3.4 Ribbon Seal (*Histriophoca fasciata*)

Ribbon seals are found in the North Pacific Ocean and parts of the Arctic Ocean, most often along the pack ice (Allen and Angliss 2010) in the Bering Sea during late winter and early spring. As the pack ice recedes in late spring, they move north (Burns 1970, Burns 1981a). As the ice recedes in May to mid-July, ribbon seals move to the northern areas of the Bering Sea, where they haul out on the ice edge. Little is known about ribbon seal summer and fall distributions, although based on a review of sightings, it is suggested (Kelly 1988) they move into the southern Chukchi Sea. Reliable information about the population size and estimate of the ribbon seal presence in Alaska is unavailable.

Ribbon seals have been sighted in the northeastern Chukchi Sea, but in very low numbers. During the 2008 CSESP survey, six ribbon seals were observed of which four in the Devils Paw prospect (Brueggeman et al. 2009b). No ribbon seals were observed during the 2009 and 2010 CSESP surveys (Brueggeman et al. 2010, Aerts et al. 2011). Boveng et al. (2008) also observed ribbon seals far offshore in the central Chukchi Sea in the summer of 2007. Ribbon seals were also sighted in low numbers during marine mammal mitigation and monitoring surveys for seismic and shallow hazard surveys in the northeastern Chukchi Sea (Haley et al. 2010). Occurrence of the ribbon seal in the Devils Paw prospect area is considered to be sporadic; therefore it is unlikely they will be encountered within the vicinity of the proposed exploration drilling activities.

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.

COP 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 exploration drilling project in the Devils Paw prospect, Chukchi Sea, during the open water season of 2014. "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.*"

Disruption of marine mammals by proposed exploration drilling activities described in Section 1 of this application may occur due to:

- Exposure to continuous sounds generated by the drill rig and by its supply and support vessels in the area of exploration drilling activities;
- Exposure to pulsed sounds from airguns during VSP data acquisition runs; or
- Physical presence of ice management or other project vessels during ice reconnaissance trips.

The response of marine mammals to these activities depends on many factors as described in Section 7 of this application. The loudest noise sources related to the drilling activity will emanate from the use of thrusters for dynamic positioning during resupply of the drill rig. Disturbance reactions, such as avoidance, are likely to occur among some marine mammals in the proximity to the drill rig and support vessels. No serious injury to marine mammals is expected given the nature of the activity. Sounds from airguns generated during the vertical seismic profile data acquisition runs are also not likely to cause serious injury in marine mammals, given the short duration that these airguns will be operating (about 2 hrs total for the two or three data acquisition runs per well, not including time required for ramp up) in conjunction with mitigation measures that will be implemented. Some disturbance reactions from airgun sounds may, however, occur. In summary, no physical injuries are reasonably expected to occur given the nature of the exploration activities and the proposed mitigation and monitoring procedures (refer to Section 11). No lethal injuries are expected.

In the event seals are present on an ice floe that is considered potentially hazardous to the operations, COP may wish to use an ice management vessel to divert the ice floe away from the rig. This scenario is unlikely to occur, but if it does, seals would likely vacate the floe, at least temporarily. If a potentially hazardous ice floeis identified and the floe contains ice seals, COP will notify the NMFS representative immediately and seek guidance.

A recent study has revealed that bowhead whales have a very well developed sense of smell. They are able to detect airborne odorants, but have not developed any underwater chemoreception, which in mammals is usually registered by taste buds in the tongue

(Thewissen et al. 2011). It has therefore been suggested that bowhead whales (and maybe also other baleen whales and pinnipeds) might avoid discharge areas of water based muds and cuttings around the jack-up rig. However, monitoring and modeling of dispersion of water based muds and cuttings discharges from many offshore platforms throughout the world show that the discharge plume will never reach surface waters (0 - 33 ft or 0 - 10 m) and will be diluted to near background within about 0.6 to 1.2 mi (1 to 2 km) (Neff, 2010; Rye and Ditlevsen, 2011). It is therefore not expected that marine mammals will actively avoid drilling discharges.

In summary, COP seeks authorization of incidental non-lethal harassment of marine mammals from continuous and pulsed sounds generated in the course of permitted activities. Sounds produced during vessel transits to and from the drilling location are similar to that of conventional vessel traffic and thus not considered subject to the IHA application process, according to guidance by NMFS.

6. NUMBER OF MARINE MAMMALS THAT MAY BE TAKEN

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 5], and the number of times such takings by each type of taking are likely to occur.

The anticipated harassments from sounds produced by the exploration drilling activities described in Section 1 involve short-term changes in behavior of marine mammals. Species most likely to be encountered in the Devils Paw prospect in relatively high numbers are ringed, spotted and bearded seals. Cetacean species, such as bowhead, gray, beluga and killer whales, and harbor porpoise also occur in the area, but will likely be encountered in low numbers in the offshore waters during the drilling season. Requests for incidental harassment authorization of ribbon seal, fin whale, humpback whale and minke whale are also included, but are minimal because these species are not commonly present in the Chukchi Sea.

This section describes the methods used to estimate the numbers of marine mammals that might be affected during the proposed drilling operation in the Devils Paw prospect, Chukchi Sea. Marine mammal occurrence near the operation varies by season and is mostly related to sea ice conditions, especially for ice seals. The proposed exploration drilling activities, including the VSP data acquisition runs, are expected to result in harassment of only a small number of marine mammals, without any significant effect on their populations. It is highly unlikely that the proposed drilling activities could result in “level A harassment” from injury, such as damage to the hearing apparatus (see Section 7.3.4). NMFS uses a threshold of 120 decibels (dB) relative to 1 microPascal (re 1 µPa) root mean square (rms) for all marine mammals under their jurisdiction for the onset of “level B harassment” from continuous non-pulsed sounds and 160 dB re 1µPa (rms) for pulsed sounds (NMFS 2005, 2010c). The estimated number of cetaceans and seals potentially affected are therefore based on their expected densities in combination with the estimated area ensonified with continuous non-pulsed sound levels of 120 dB re 1µPa (rms) or more, and pulsed sound levels of 160 dB re 1µPa (rms) or more.

There is no evidence, however, that avoidance at received continuous sound levels of 120 dB re 1µPa (rms) or more or pulsed sound levels of 160 dB re 1µPa (rms) or more would have significant effects on individual animals or that the subtle changes in behavior or movements would constitute “level B harassment” (NMFS 2001, p 9293). Any changes in behavior caused by these sound levels would likely fall within the normal variation of behavioral patterns and would also occur in the absence of the drilling project (see Section 7 for more detail on potential impacts).

6.1 Marine Mammal Density Estimates

Density estimates are based on the best available peer reviewed scientific data, when available. In cases where the best available data were collected in regions, habitats, or seasons that differ from the proposed survey activities, adjustments to reported population or density estimates were made to account for these differences insofar as possible. In cases where the best available peer reviewed data was based on data from more than a decade old, more recent information was used. Species abundance information in the northeastern Chukchi Sea from the 2008-2010 COMIDA marine mammal aerial surveys (Clarke and Ferguson 2010, Clarke et al. 2011) and the 2008-2010 vessel-based CSESP (Aerts et al. 2011) contain current knowledge of some whale and seal species. The data from the COMIDA aerial survey has undergone several reviews, so although not officially peer reviewed, this recent abundance and distribution data was believed to be more representative than older peer reviewed publications for bowhead and gray whales. The CSESP data is as of yet preliminary so is presently only used as a comparison to available peer reviewed data, unless no other information was available. In those cases the CSESP data was used to estimate densities.

Because most cetacean species show a distinct seasonal distribution, density estimates for the northeastern Chukchi Sea have been derived for two time periods; the summer period (covering July and August) and the fall period (covering September and October). Animal densities encountered in the Chukchi Sea during both of these time periods will further depend on the presence of ice. However, if ice is present close to the project area drilling operations will not start or will be halted, so cetacean densities related to ice conditions are not included in this IHA application. Pinniped species in the Chukchi Sea do not show a distinct seasonal distribution during the period July-October (Aerts et al. 2011) and as such density estimates derived for seal species are used for both the summer and fall periods.

Some sources from which densities were used include correction factors to account for perception and availability bias in the reported densities. Perception bias is associated with diminishing probability of sighting with increasing lateral distance from the trackline, where an animal is present at the surface but could be missed. Availability bias refers to the fact that the animal might be present but is not available at the surface. In cases where correction factors were not included in the reported densities, the best available correction factors were applied.

To account for variability in marine mammal presence, maximum density estimates were derived in addition to average density estimates. Except where specifically noted, the maximum estimates have been calculated as double the average estimates. This factor was believed to be large enough to allow for chance encounters with unexpected large groups of animals or for overall higher densities than expected.

6.1.1 Cetacean Densities

Eight species of cetaceans are known to occur in the northeastern Chukchi Sea. Of these species the bowhead whale (ESA-listed), beluga whale, gray whale, and harbor porpoise are likely to be encountered during the proposed drilling activities. The fin whale (ESA-listed), humpback whale (ESA-listed), minke whale, and killer whale can be expected in the area, but not in large numbers. Recent literature does not mention any narwhal sightings in the Chukchi Sea, but subsistence hunters occasionally reported observations near Barrow, and Reeves et al. (2002) indicated a small number of extralimital sightings in the Chukchi Sea. However, occurrences of narwhal are considered unlikely in the Devils Paw prospect and therefore no estimates are provided for the number of narwhal potentially exposed to sound levels generated by the proposed activities.

Beluga Whale

Summer densities of belugas in offshore waters of the Chukchi Sea are expected to be low, with higher densities at the ice-margin and in nearshore areas. Aerial surveys have recorded few belugas in the offshore Chukchi Sea during the summer months (Moore et al. 2000b). COMIDA aerial surveys flown in 2008, 2009 and 2010 reported a total of 733 beluga sightings during >32,202 mi (51,824 km) of on-transect effort, resulting in 0.0141 beluga whales per km (Clarke et al. 2011). Belugas were seen every month except September, with most sightings in July.

There was one sighting of nearly 300 belugas nearshore between Wainwright and Icy Cape in 2009, and several hundred belugas were sighted in Elson Lagoon, east of Pt. Barrow in 2010. Group size ranged from 1 to 480 individuals. Highest sighting rate per depth zone was in shallow water (less than or equal to [≤] 115 ft [35 m] depth), which was likely due to the large groups described above. No beluga whales were sighted during the 2008-2010 vessel-based marine mammal CSESP surveys that covered the Devils Paw prospect and two other lease areas in the northeastern Chukchi Sea (Brueggeman et al. 2009b, 2010, Aerts et al. 2011). Some beluga vocalizations were detected in October 2009 around Barrow and in the Burger lease area by acoustic recorders deployed as part of the CSESP program, but none in the Devils Paw prospect (Delarue et al. 2011). Also, no beluga sightings were reported during >11.185 mi (18,000 km) of vessel-based effort in good visibility conditions during 2006–2008 industry operations in the northeastern Chukchi Sea (Haley et al. 2010).

The COMIDA aerial survey summer and fall data (Clarke et al. 2011) were used to calculate expected average densities in the Devils Paw prospect. Because the reported densities (Whales Per Unit Effort) are not corrected for perception or availability bias, a f(0) value of 2.841 and g(0) value of 0.58 from Harwood et al. (1996) were applied to arrive at estimated corrected densities, using the equation from Buckland et al. (2001). In the months July and August, two on-transect beluga sightings of five animals were observed in water depths of 36-50 m along 7,447 mi (11,985 km) line transect. After applying the correction factors mentioned above, this resulted in a density of 0.0010 whales/km^2 (Table 4). The three on-transect beluga sightings of six animals recorded in the period September-October along 6,236 mi (10,036 km) effort resulted in a corrected density of 0.0015 whales/km^2.

The absence of any beluga sightings during the 2008-2010 CSESP marine mammal research (Brueggeman et al. 2009b, 2010, Aerts et al. 2011), the 2006-2008 industry programs (Haley et al. 2010) and the low number of acoustic detections in the vicinity of the project area (Delarue et al. 2011), are consistent with the relative low summer and fall densities in water depths of 118-164 ft (36-50 m) as calculated with the COMIDA aerial survey data.

Bowhead Whales

Most bowhead whales that will be observed in the northeastern Chukchi Sea are either migrating north to feeding grounds in the eastern Beaufort Sea during spring, or migrating south to their wintering grounds in the Bering Sea during the fall. During spring migration, bowheads occur relatively close to shore, using leads in the sea ice. By July, most bowhead whales have passed Point Barrow, although some have been visually and acoustically detected during the entire summer in low numbers in the northeastern Chukchi Sea (Moore et al. 2010, Thomas et al. 2010, Quakenbush et al. 2010, Clarke and Ferguson *in prep.*). Bowheads are more widely scattered in the northeastern Chukchi Sea during the fall migration, but generally keeping an offshore route. During aerial surveys in the COMIDA area from 1982-1991 and 2008-2010, a total of 88 on-effort sightings of 121 bowhead whales were observed. Bowhead whales were seen in all months from June to October, with the greatest number of sightings occurred in October (Clarke et al. 2011, Clarke and Ferguson *in prep.*). Similarly, bowhead whales were sighted in July-August during nearshore aerial surveys conducted in 2006-2008 in the northeastern Chukchi Sea, but with increasing number of sightings in September and October (Thomas et al. 2010). Vessel-based CSESP marine mammal surveys conducted in Devils Paw prospect and two other lease areas in the northeastern Chukchi Sea recorded a total of 40 sightings of 59 animals during 2008-2010, with all but one sighting in October (Brueggeman et al. 2009, 2010, Aerts et al. 2011).

The estimate of summer and fall bowhead whale density in the Chukchi Sea was calculated using the 2008-2010 COMIDA aerial survey data (Clarke and Ferguson *in prep.*). No bowhead whales were sighted during the 7,447 mi (11,985 km) of survey effort in waters of 118-164 ft (36-50 m) during July–August, however, for density estimates of this IHA application we assumed there was one bowhead sighting of one animal. To improve the understanding of what factors significantly affect bowhead whale detections from aerial surveys, a distance detection function was estimated using 25 years of aerial line transect surveys in the Bering, Chukchi and Beaufort Seas (Givens et al. 2010). Because the correction factor from this study is less conservative than the estimates by Thomas et al (2002), we used the more conservative values to estimate densities for the purpose of this IHA application. When applying a f(0) value of 2 and a g(0) value of 0.07 from Thomas et al. (2002), the summer density was estimated to be 0.0012 whales/km^2 (Table 4). Clarke and Ferguson (*in prep.*) reported 14 sightings of 15 individuals during 6.236 mi (10,036 km) of on transect aerial survey effort in September and October of 2008-2010. Applying the same f(0) and g(0) values as for the summer density estimate, the bowhead density estimate for the fall is 0.0214 whales/km^2 (Table 4). A total of 36 on-transect sightings of 55 bowheads were observed along 8,169 mi (13,146 km) transect effort during the vessel-based CSESP marine mammal surveys in September and October. Applying the same correction factors as above resulted in a corrected bowhead density of 0.0598 whales/km^2. This high density coincided with a peak in whale migration the first week of October, which was also apparent on the acoustic records (Delarue et al. 2011). Although none of these sightings were in the Devils Paw prospect, the maximum fall bowhead density estimate has been calculated as triple the average estimates, to cover for such migration peaks.

Gray Whale

Gray whale densities are expected to be highest in nearshore areas during the summer months with decreasing numbers in the fall. Moore et al. (2000b) reported a scattered distribution of gray whales generally limited to nearshore areas where most whales were observed in water less than 35 m deep. Nearshore aerial surveys along the Chukchi coast also reported substantial declines in the sighting rates of gray whales in the fall (Thomas et al. 2010). The average open-water summer and fall densities presented in Table 4 were calculated from the 2008-2010 COMIDA aerial survey data (Clarke and Ferguson *in prep.*). The summer data for water depths 118-164 ft (36–50 m) included 54 sightings of 73 individuals during 7,447 mi (11,985 km) of on-transect effort. Applying the correction factors f(0) = 2.49 and g(0) = 0.95 (Forney and Barlow 1998; Table 1, based on aerial survey data) resulted in a summer density of 0.0080 whales/km^2 (Table 4). The number of gray whale sightings in the offshore study areas during the 2008-2010 CSESP marine mammal survey were limited in July and August; eight sightings of nine animals along 4,223 mi (6,796 km) on-transect effort. Most of these animals were observed nearshore of Wainwright (Brueggeman et al. 2009, 2010, Aerts et al. 2011) and only two sightings of three animals were recorded in the Devils Paw Prospect. . Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July and August of 2006-2008 (Haley et al. 2010) ranged from 0.0021 to 0.0080 whales/km^2 with a maximum 95 percent CI of 0.0336.

In the fall, gray whales may be dispersed more widely through the northern Chukchi Sea (Moore et al. 2000b, Clarke and Ferguson *in prep.*), but overall densities are likely to be decreasing as the whales begin migrating south. The average fall density was calculated from 15 sightings of 19 individuals during 6,236 mi (10,036 km) of on-transect effort in water 118-164 ft (36–50 m) deep during September and October (Clarke and Ferguson *in prep.*). Applying the same f(0) and g(0) values as for the summer density, resulted in 0.0025 whales/km^2 (Table 4). During the

CSESP survey in September and October 25 gray whale sightings of 36 individuals were observed along 8,169 mi (13,146 km) of on-transect effort, resulting in an uncorrected density of 0.0027 whales/km^2. Most of these whales were, however, observed nearshore of Wainwright (within 31 mi [50 km] from the coast) and none in the Devils Paw Prospect. Densities from vessel based surveys in the Chukchi Sea during non-seismic periods and locations in July and August of 2006-2008 (Haley et al. 2010) ranged from 0.0026 to 0.0042 whales/km^2 with a maximum 95% CI of 0.0277.

Harbor Porpoise

Distribution and abundance data of harbor porpoise were very limited prior to 2006, and presence of the harbor porpoise was expected to be very low in the northeastern Chukchi Sea. Starting 2006, several vessel-based marine mammal observer programs took place in the northeastern Chukchi Sea as part of seismic and shallow hazard survey monitoring and mitigation plans (Haley et al. 2010). During these surveys 37 sightings of 61 harbor porpoises were reported. Three on-transect sightings of seven harbor porpoises were observed in the Devils Paw prospect in July and August along 4,223 mi (6,796 km) of on-transect effort during the CSESP marine mammal surveys. No harbor porpoises were observed in the fall (Brueggeman et al. 2009, 2010, Aerts et al. 2011). The 2008-2010 CSESP data was used to calculate densities for the purpose of this IHA application. The uncorrected average density for the summer based on the three year CSESP data is 0.0010 porpoises/km^2 (Table 4). As a comparison, summer density estimates from 2006–2008 marine mammal monitoring and mitigation programs during non-seismic periods ranged from 0.0008 to 0.0015 animals/km^2 with a maximum 95 percent CI of 0.0079 animals/km^2 (Haley et al. 2010).

Assuming that 1 sighting of 1 animal would have been observed along 8,169 mi (13,146 km) transect effort during the 2008-2010 CSESP surveys in the fall, the average uncorrected fall density is 0.0001 porpoises/km^2 (Table 4). Harbor porpoise densities recorded during non-seismic periods in the fall months of 2006-2008 ranged from 0.0002 to 0.0011 animals/km^2 with a maximum 95 percent CI of 0.0093 animals/km^2. The maximum value of 0.0011 animals/km^2 from these surveys was used as the maximum fall density estimate for this IHA application (Table 4).

Other Cetaceans

The remaining cetacean species that could be encountered in the Chukchi Sea during COP's planned activities include the humpback whale (ESA-listed), fin whale (ESA-listed), minke whale, and killer whale. The northeastern Chukchi Sea is at the northern edge of the known distribution range of these animals, although in recent years several sightings of some of these cetaceans were recorded in the area. During the 2008-2010 marine mammal aerial surveys in the COMIDA area, one humpback and one fin whale were observed, but none were observed in 1982-1991 in the same area (Clarke et al. 2011). Two sightings of four fin whales were recorded in 2008 in the northeastern Chukchi Sea during 2006-2008 marine mammal monitoring programs from seismic and shallow hazard survey vessels (Haley et al. 2010). During the vessel-based 2008-2010 CSESP marine mammal surveys two killer whale pods of 9 individuals were observed in the Devils Paw prospect and also one minke whale (Brueggeman et al. 2009, 2010, Aerts et al. 2011). So, although there is evidence of the occurrence of these animals in the Chukchi Sea, it is unlikely that more than a few individuals will be encountered during the planned activities. The expected average densities of these species for the purpose of this IHA application are therefore estimated at 0.0001 animal/km^2. The maximum density estimates have been calculated as quadruple the average estimates, to account for the increasing trend in number of observations during recent years (Table 4).

6.1.2 Pinniped Densities

Four species of pinnipeds under NMFS jurisdiction occur in the Chukchi Sea during COP's planned activities of which three are most likely to be encountered: ringed seal, bearded seal, and spotted seal. For completeness, all four species are discussed. Each of these species is associated with presence of ice and the nearshore area. For ringed and bearded seals the ice margin is considered preferred habitat during most seasons (as compared to the nearshore areas). Spotted seals are considered to be predominantly a coastal species except in the spring when they may be found in the southern margin of the retreating sea ice. Satellite tagging studies have shown that spotted seals sometimes undertake long excursions into offshore waters during summer (Lowry et al. 1994, 1998). Ribbon seals were observed during the vessel-based CSESP surveys in 2008, when ice was present in the area (Brueggeman et al. 2009) and they were also reported in very small numbers within the northeastern Chukchi Sea by observers on industry vessels (Haley et al. 2010).

Aerial survey data from Bengston et al. (2005) were initially used for bearded and ringed seal densities. However, because these surveys were conducted in the spring during the seal basking season the reported densities might not be applicable for the open water summer and fall period. Therefore, the 2008-2010 CSESP vessel-based marine mammal survey data were used to calculate seal densities. The densities for spotted and ribbon seals were also based on the 2008-2010 CSESP marine mammal survey data (Aerts et al. 2011). Perception bias was accounted for in the CSESP densities, but the number of animals missed because they were not available for detection was not taken into account. The assumption was made that all animals available at distance zero from the observer, this is on the transect line, were detected [g(0)=1]. The amount of animals missed due to perception bias was calculated using distance sampling methodology (Buckland et al. 2001; Buckland et al. 2004). Program Distance 6.1 release 1 (Thomas et al. 2010) was used to analyze effects of distance and environmental factors (e.g., sea state, visibility) on the probability of detecting marine mammal species.

During the CSESP studies a relatively large percentage of seal sightings was classified as ringed/spotted seals (meaning it was either a spotted or a ringed seal) and unidentified seals (meaning it could be any of the four seal species observed). These sightings had to be taken into account to avoid an underestimation of densities for each separate seal species. The ratio of ringed versus spotted seal densities for each study area and year was used to estimate the proportional density of each of these two species from the combined ringed/spotted seal densities. This estimated proportional density was then added to the observed densities. The same method was used to proportionally divide the unidentified seal sightings over spotted, ringed, and bearded seal sightings. Applying the ratio of identified seal species to the unidentified individuals assumes that the disability of identification is similar for each species. Considering the conditions of these occurrences (animals either far away or only at the surface for a very brief moment), this is very likely to be true. The above described adjustment increased densities for each species, but did not change observed trends in occurrence.

Bearded Seals

Densities from 1999-2000 spring surveys in the offshore pack ice zone (zone 12P) of the northern Chukchi Sea (Bengtson et al. 2005) were initially consulted for bearded seal average and maximum summer densities. A correction factor for bearded seal availability bias, based on haul out and diving patterns was not available and therefore not included in the reported densities. Average density of bearded seals on the offshore pack ice in zone 12P was 0.018 seals/km^2, with a maximum density of 0.027 seals/km^2 (Bengston et al. 2005). During the 2008-2010 CSESP marine mammal survey, bearded seal density in the Devils Paw prospect from July-October was 0.025 seals/km^2 in 2008, 0.004 seals/km^2 in 2009, and 0.011 seals/km^2 in 2010 (Aerts et al. 2011). The average density over these three years was 0.014 seals/km^2, and the maximum density 0.025 seals/km^2. The average density of the CSESP surveys is about 30% lower than reported by Bengston et al. (2005) and the maximum CSESP densities about 10% lower. It was decided to use the CSESP average and maximum densities data as these were gathered in the area of operation during the same season as the proposed operations (Table 4).

Ringed Seals

Ringed seal average and maximum summer densities were also calculated from the 1999-2000 spring aerial survey data in the offshore pack ice zone (zone 12P) of the northern Chukchi Sea (Bengtson et al. 2005). Ringed seal availability bias, g(0), based on haul out and diving patterns was used in the reported densities. Average density of ringed seals on the offshore pack ice in zone 12P was 0.052 seals/km^2, and the maximum density 0.81 seals/km^2 (Bengston et al. 2005). During the 2008-2010 CSESP marine mammal survey, ringed seal density in the Devils Paw prospect from July-October was 0.126 seals/km^2 in 2008, 0.018 seals/km^2 in 2009, and 0.012 seals/km^2 in 2010 (Aerts et al. 2011). The average density over these three years was 0.052 seals/km^2, and the maximum density 0.126 seals/km^2. The average density of the CSESP surveys is very similar to that reported by Bengston et al. (2005), but the maximum CSESP density was about 6 times lower. As with the bearded seal density, it was decided to use the CSESP average and maximum densities data as these were gathered in the area of operation during the same season as the proposed operations (Table 4). The maximum density was obtained in a year when ice was present in the area.

Spotted Seal

Little information is available on spotted seal densities in offshore areas of the Chukchi Sea. Spotted seal densities were calculated based on the data collected during the CSESP marine mammal survey (Aerts et al. 2011). Spotted seal density in the Devils Paw prospect from July-October was 0.036 seals/km^2 in 2008, 0.019 seals/km^2 in 2009, and 0.018 seals/km^2 in 2010 (Aerts et al. 2011). The average density over these three years was 0.024 seals/km^2, and the maximum density 0.036 seals/km^2 (Table 4).

Ribbon Seal

Four ribbon seal sightings of 4 individuals were recorded in the Devils Paw prospect during the CSESP survey from July-October 2008 (Brueggeman et al. 2009). No ribbon seals were sighted in 2009 and 2010 (Brueggeman et al. 2010, Aerts et al. 2011). Density calculated from this limited number of sightings in 2008 was 0.006 seals/km^2. The average and maximum densities were 0.002 seals/km^2 and 0.006 seals/km^2, respectively. Note that the 2008 density calculated for this IHA application had, as expected, an extremely large coefficient of variation due to the limited number of sightings.

Table 4 Estimated Densities of Cetaceans and Pinnipeds in the Northeastern Chukchi Sea as Representative Densities Expected during COP's Planned Drilling Operations in the Devils Paw Prospect in the Open Water Period of 2014

Density in Numbers per Square km	July/August		September/October	
	Avg	Max	Avg	Max
Beluga whale	0.0010	0.0020	0.0015	0.0030
Killer whale	0.0001	0.0004	0.0001	0.0004
Harbor porpoise	0.0010	0.0020	0.0001	0.0011
Bowhead whale	*0.0012*	*0.0024*	*0.0214*	*0.0641*
Gray whale	0.0080	0.0160	0.0025	0.0050
Humpback whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Fin whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Minke whale	0.0001	0.0004	0.0001	0.0004
Bearded seal	0.0135	0.0248	0.0135	0.0248
Ringed seal	0.0516	0.1256	0.0516	0.1256
Spotted seal	0.0244	0.0355	0.0244	0.0355
Ribbon seal	0.0020	0.0060	0.0020	0.0060

Note:
Species listed under the U.S. ESA as Endangered are in italics.

6.2 Estimated Distances to Level A and Level B Harassment Criteria

An acoustic propagation model, i.e., JASCO's Marine Operations Noise Model, was used to estimate distances to received rms sound pressure levels (SPL) of 190, 180, 160, and 120 dB re 1µPa from the drill rig, support vessel on dynamic positioning alongside the drill rig, and from the VSP airguns. The distances to reach received sound levels of 120 dB re 1 µPa (for continuous sound sources, such as drilling activities, support vessels, and ice management) and 160 dB re 1 µPa (for pulsed sound sources, such as the VSP airguns) will be used to calculate the potential numbers of marine mammals potentially harassed by the proposed activities. The distances to received levels of 180 dB and 190 dB re 1 µPa (rms) will be used to establish exclusion zones for mitigation purposes (see Section 11). Three scenarios were considered for modeling:

1. Jack-up rig performing drilling operations (without support vessels);
2. Jack-up rig performing drilling operations with the support vessel alongside in dynamic positioning mode, i.e., maintaining position using thrusters; and
3. 760 in^3 ITAGA airgun array operating at the drill site as representative for VSP data acquisition runs.

The results of these model runs are shown in the report "Acoustic Modeling of Underwater Noise from Drilling Operations at the Devils Paw prospect in the Chukchi Sea" (Attachment A of this IHA application) and are summarized in Table 5.

The ice management vessel is part of an ice alerts system, and available to assist operations by conducting ice reconnaissance trips and protecting the rig from potential ice hazards if necessary. COP does not expect physical management of ice to be necessary during the open water season and does not intend to engage in icebreaking. If ice floes are determined to require a managed response to protect the drill rig, the use of fire monitors (water cannons) or the vessel itself to modify ice floe trajectory is the most likely response. As summarized in Section 7.2.2, a sound pressure level of about 193 dB re 1µPa at 1 m was estimated to be a reasonable peak value for ice management vessels during different sea ice conditions and modes of propulsion level (Roth and Schmidt 2010). Sound levels generated during physical management of ice are not expected to be as intense as during icebreaking activities described in most literature. During physical management of ice, the vessel's propeller will be rotating at approximately 15–20 percent of the vessel's propeller rotation capacity. Instead of actually breaking ice, the vessel will redirect and reposition the ice with slow movements, pushing it away from the direction of the drill rig at slow speeds so that the ice floe does not form any hazard to the drilling operations. At these slow speeds the vessel uses low power, with slow propeller rotation speed, thereby reducing noise generation from propeller rotation effects in the water.

Marine mammals have been observed to display behavioral reactions at distances out to 10-12 mi from ice breaking activities (Brueggeman et al. 1990). For the purpose of estimating the number of marine mammals (in water) potentially eliciting behavioral responses, we assume that the distance to received sound pressure levels of 120 dB re 1µPa from physical ice management is similar to that modeled for the support vessel on dynamic positioning, i.e. 4.9 mi (7.9 km). This is considered to be conservative, since source levels from the proposed physical management of ice are expected to be much lower than the 204 dB re 1µPa used for the support vessel and also lower than the 193 dB re 1µPa reported for icebreaking activities.

Table 5. Summary of modeled distances to received sound pressure level criteria (SPL rms) used by NMFS for the onset of Level A (190 and 180 dB) and Level B Harassments (160 and 120 dB) for relevant sound sources of the proposed project and areas used for estimating the number of potential marine mammal harassments.

Sound Source	Received SPL (dB re 1 µPa)	Modeled Distance (km)	Area (km^2) used*
Continuous sound source			
Drilling	160 dB	<0.01	--
	120 dB	0.21	--
Support vessel in dynamic positioning	160 dB	0.71	--
	120 dB	7.90	201
Ice management	160 dB	0.71	--
	120 dB	7.90	201
Pulsed sound source			
VSP airguns	190 dB	0.16	--
	180 dB	0.92	--
	160 dB	4.90	78.5
	120 dB	71.0**	--

** Areas ensonified with continuous sound levels of 120 dB and pulsed sound levels of 160 dB displayed in this column were used to estimate the number of marine mammals potentially exposed to these levels (see Section 6.2.1). -- means not applicable*

*** Contours of 120 dB re 1 µPa for airgun sounds extended beyond the modeling area and as such the distance shown is based on extrapolation of the data and therefore uncertain.*

6.2.1 Potential Number of Incidental Harassments

NMFS uses a threshold of 120 dB re 1 µPa (rms) for all marine mammals under their jurisdiction for the onset of "level B harassment" from continuous non-pulsed sounds and 160 dB re 1µPa (rms) for pulsed sounds (NMFS 2005, 2010c). The radii associated with received sound levels of 120 and 160 dB re 1 µPa (rms) or higher are therefore used to calculate the number of potential marine mammal exposures to sounds. The 160 dB criterion is applied to pulsed sounds generated by airguns during the two or three VSP data acquisition runs that will be of short duration (with a total of about 2 hrs of airgun activity for two to three runs per well, not including time required for ramp up). The 120 dB criterion is applied to sounds from the drill rig for situations where the support vessel is located alongside the drill rig in dynamic positioning mode, i.e., the scenario with highest sound production. This situation will occur about 4 times a week for a maximum of 6 hrs per occurrence, i.e., about 318 hrs of dynamic positioning based on 53 trips over the entire drilling season for the ware vessel and 4.5 times a week, i.e., about 378 hrs for the OSV. The 120 dB criterion is also applied to any physical management of ice that might occur. For analytical purposes, physical ice management was conservatively estimated at up to 72 hrs, only in July and August. The area ensonified with continuous sound levels of 120 dB re1 µPa (rms) during drilling activity only is so small (<0.2 km^2) that it does not appreciably add to the total estimated number of marine mammal exposures and is therefore not included in the calculations.

The area around the drill rig ensonified with pulsed sound levels of greater than or equal to [≥]160 dB re1 µPa (rms) during VSP runs is estimated at 30 square miles (mi^2) (78.5 km^2; radius of 3.1 mi or 5 km), and 78 mi^2 (201 km^2; radius of 5 mi or 8 km) for continuous sound levels of ≥120 dB re1 µPa (rms) during times when the support vessel is attending the rig and during physical management of ice (Table 5).

The potential number of each species that might be exposed to received continuous sound pressure levels of ≥120 dB re 1 µPa (rms) and pulsed sound pressure levels of ≥160 dB re 1 µPa (rms) was calculated by multiplying:

- the expected (seasonal) species density as provided in Table 4 of Section 6.1
- the anticipated area to be ensonified by the 120 dB re 1 µPa (rms) sound pressure level (support vessel in dynamic positioning mode and ice management activity) and 160 dB re 1 µPa (rms) sound pressure level (VSP airgun operations); and
- the estimated total duration of each of the three activities within each season expressed in days (24 hrs).

To derive at an estimated total duration for each of the three activities for each season (summer and fall) the following assumptions were made:

- The total duration during which the support vessel will be in dynamic positioning mode is 318 + 378 = 696 hrs. This is the equivalent of 29 days over the entire season, with 14.5 days in July/August and 14.5 days in September/October.
- Physical management of ice was assumed to take place only in the early season and, for analytical purpose, estimated at a total of 72 hrs. No physical management of ice is

assumed in September or October. If sea ice becomes an issue in October, drilling activities will likely be halted and the drill rig prepared for demobilization.

- The ensonified area of 120 dB re 1µPa for continuous sounds of the support vessel in dynamic positioning mode and active ice management are assumed to be similar. To be conservative, we assume that the ensonified areas of these two activities will not overlap. The duration of both these activities combined, used to calculate marine mammal exposures to 120 dB re 1 µPa (rms), is therefore17.5 days (=14.5 + 3) for July/August and 14.5 days for September/October.

- The total duration of the two or three VSP data acquisition runs per well is estimated to be 24 hrs, during which the airguns will be operating a total of about 2 hrs. Assuming COP will do additional VSP data acquisition runs for a second well, the total time of operating airgun activity is estimated at about 4 hrs. To be conservative and airgun time for ramp ups, we have used 12 hrs (0.5 day) in July/August and 12 hrs (0.5 day) in September/October for the calculations of potential exposures.

Table 6 summarizes the number of marine mammals potentially exposed to continuous sound pressure levels of 120 dB re 1 µPa from support vessels on dynamic positioning and physical ice management. Table 7 summarizes the estimated number of marine mammals potentially exposed to pulsed sound pressure levels of 160 dB re 1 µPa during the VSP runs. The total number of potential marine mammal exposures from all three activities combined is provided in Table 8.

Cetaceans

The total estimated number of bowhead whales potentially exposed to sound levels that may elicit behavioral responses ranges from 68−200 (Table 8). Bowhead whales use the Chukchi Sea mainly as migratory corridor. The range of potential bowhead whale exposures seems to be a reasonable estimate, because most bowhead whales migrate close to shore during the spring migration and the number of summering bowheads in the Chukchi Sea is low. In 2011, a total of seven bowhead whales were observed in the Devils Paw Prospect in August (Aerts, pers. comm.). Satellite tagging data shows that the probability that bowhead whales pass through the Devils Paw Prospect during the fall is also low (Quakenbush et al. 2010). Bowhead whale call count data from 2009 and 2010 confirms the satellite tagging data showing that the Devils Paw Prospect is located on the southern edge of the bowhead whale fall migration corridor (Delarue et al. 2011). Observers from vessel-based and aerial surveys have recorded only few bowheads in the Devils Paw Prospect. COP therefore requests authorization for the average number of bowhead whales (rounded to 70), which is considered to be conservative enough because the density data upon which the calculation is based also covers areas known to lie within the fall bowhead migration corridor.

Gray whales are very common in the Chukchi Sea during the entire open water period. They mainly feed in nearshore waters. The total estimated number of gray whales potentially exposed to sound levels that may elicit behavioral responses ranges from 35−72 (Table 8). As discussed in Section 6.1.1, these numbers seem high for the Devils Paw Prospect based on available visual observations and the fact that their distribution is mainly nearshore. Because the activities for which authorization is requested are mainly occurring offshore, COP requests authorization for the average number of gray whales (35).

Beluga whales are also common in the Chukchi Sea, but are not commonly observed in the Devils Paw Prospect or the other lease areas during summer and fall and their estimated total number of exposures is therefore low (8−16; Table 8). No beluga whales have been observed in the Devils Paw Prospect in 2008−2010 (Aerts et al. 2011), nor in 2011 (Aerts, pers.comm.). The number of acoustic detections recorded in the vicinity of the project area is also low (Delarue et al. 2011). We request authorization for the maximum number of beluga whales, rounded to 10, because they can travel in groups.

The other cetacean species that may occur are uncommon for the Chukchi Sea (killer whale, harbor porpoise, minke whale, fin whale, and humpback whale). Of these species the minke whale, killer whale, and harbor porpoise have been observed in the Devils Paw Prospect during two of the four years of CSESP vessel-based surveys. Any of these species can be encountered, but likely in low numbers. The maximum numbers for each of these species is used for the requested authorization. In cases the maximum number is lower than 5 the number has been increased to 5 to account for unusual sighting events.

Pinnipeds

Pinnipeds are present in the Chukchi Sea during the entire season, where they travel large distances during the open water period. It is possible though that some seals might stay in the area around the rig for a few hours or so, resulting in re-sightings of the same animal. The ringed seal and spotted seals are expected to be the most common species, with estimated total number of exposures ranging from 335−818 and 159−231, respectively. Because the maximum number of potential exposures of ringed and spotted seals were based on densities from a year when there was ice present in the Devils Prospect area (resulting in a substantial increase in number of these species compared to the other two years), we used the average numbers for the requested authorizations (rounded). The same is true for the ribbon seals. The number of potential exposures of bearded seals was estimated to range from 88−161 (Table 8). The requested authorization is based on the maximum number, because the number of bearded seals observed in 2011 was higher than expected based on the 2008−2010 data (Aerts, pers.comm.).

6.2.2 Summary

Due to the nature of exploration drilling operations, with most sound generating activities associated with a fixed location (the drill rig),any effects on cetaceans are generally expected to be restricted to avoidance of the area around the drill rig. Most cetaceans in the area would be migrating, so any possible exposure would be short-term and result in not more than brief subtle changes in behavior that fall within the natural variation of behavioral patterns. Because of the predictability of the exposed area, pinnipeds will either avoid the area or, if exposed, show a brief subtle behavioral response that will not lead to the level of taking as defined by NMFS (2001).

Table 6 Estimated Numbers of Marine Mammals Potentially Present in Areas with Received Continuous Underwater Sound Levels of ≥120 dB in Summer (Jul/Aug) and Fall (Sep/Oct) during COP's Proposed Drilling Activities in the Devils Paw Prospect.

Species	Number of Individuals Exposed to ≥120 dB					
	July/August		September/October		Total	
	Avg	Max	Avg	Max	Avg	Max
Beluga whale	4	7	4	9	8	16
Killer whale	0	1	0	1	1	2
Harbor porpoise	4	7	0	3	4	10
Bowhead whale	4	8	62	187	66	195
Gray whale	28	56	7	14	35	71
Humpback whale	0	1	0	1	0	2
Fin whale	0	1	0	1	0	2
Minke whale	0	1	0	1	0	2
Bearded seal	48	87	39	72	87	159
Ringed seal	181	442	150	366	331	808
Spotted seal	86	125	71	103	157	228
Ribbon seal	7	21	6	17	13	38

Table 7 Estimated Numbers of Marine Mammals Potentially Present in Areas with Received Pulsed Underwater Sound Levels of ≥160 dB in Summer (Jul/Aug) and Fall (Sep/Oct) Periods during COP's Planned VSP Data Acquisition Runs

	Number of Individuals Exposed to ≥160 dB					
	July/August		September/October		Total	
Species	Avg	Max	Avg	Max	Avg	Max
Beluga whale	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0
Harbor porpoise	0	0	0	0	0	0
Bowhead whale	0	0	2	5	2	5
Gray whale	0	1	0	0	0	1
Humpback whale	0	0	0	0	0	0
Fin whale	0	0	0	0	0	0
Minke whale	0	0	0	0	0	0
Bearded seal	1	1	1	1	1	2
Ringed seal	2	5	2	5	4	10
Spotted seal	1	1	1	1	2	3
Ribbon seal	0	0	0	0	0	0

Table 8 The Total Estimated Number of Marine Mammals Potentially Exposed to Received Sound Levels of ≥120 dB from Continuous Sound Sources and ≥160 dB from Pulsed Sound Sources during COP's Proposed Activities.

Species	Total Number of Individuals Potentially Exposed		Total Requested Authorization
	Average	Maximum	
Beluga whale	8	16	10
Killer whale	1	2	5(20)
Harbor porpoise	4	10	10
Bowhead whale	68	200	70
Gray whale	35	72	35
Humpback whale	0	2	5
Fin whale	0	2	5
Minke whale	0	2	5
Bearded seal	88	161	160
Ringed seal	335	818	340
Spotted seal	159	231	160
Ribbon seal	13	38	15

Note:

- Not all marine mammals will change their behavior when exposed to these sound levels.
- The number of 20 is included in the requested authorization for killer whales, because they have been observed in pods of several animals in recent years.

7. ANTICIPATED IMPACT ON SPECIES OR STOCKS

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

This section summarizes the potential impacts of sounds generated during drilling operations and VSP data acquisition runs on marine mammals based on available literature. The possible impacts of the planned offshore exploration drilling project on marine mammals could be related to sounds generated by the drilling activity, supply and support vessels on dynamic positioning, aircraft, and VSP airguns. Risk of collisions between marine mammals and vessels involved in the operations is considered to be negligible, because the vessels will be on standby the majority of the time or traveling at low speeds of less than 10 knots (18 kilometers per hour [kph]). Also, the area of vessel movements is relatively small and the marine mammal density in the area and season of operation is low, especially for cetaceans. It has been suggested that bowhead whales (and maybe also other baleen whales and pinnipeds) might avoid discharge areas of water based muds and cuttings around the jack-up rig, since recent study has revealed that bowhead whales have a very well developed sense of smell. They are able to detect airborne odorants, but have not developed any underwater chemoreception, which in mammals is usually registered by taste buds in the tongue (Thewissen et al. 2011). Monitoring and modeling of dispersion of water based muds and cuttings discharges from many offshore platforms throughout the world show that the discharge plume will never reach surface waters (0 - 33 ft [0 - 10 m]) and will be diluted to near background within about 0.6 to 1.2 mi (1 to 2 km) (Neff, 2010; Rye and Ditlevsen, 2011). Marine mammals are therefore not expected to actively avoid drilling discharges.

The remote possibility of an oil spill and potential consequences of an oil spill are not within the scope of specified activities for which COP seeks an IHA. For a description of possible impacts to marine mammals and their habitat, and to subsistence uses of marine mammals as a result of an unlikely event of an oil spill and response activities we refer to Sections IV.C.1 f(1), IV.C.1 h, and IV.C.1 I of MMS' Chukchi Sea Planning Area Final EIS of Lease Sale Area 193 (MMS 2007). In this final EIS, MMS (now BOEM) addressed potential impacts from the unlikely event of a large oil spill greater than or equal to (≥) 1,000 barrels (bbl). MMS concluded that the effects of a large oil spill and subsequent exposure of whales to fresh crude oil are uncertain, speculative, and controversial. Table A.2-75 in Appendix A (MMS 2007) provides further information concerning the low likelihood (<0.507% within 30 days over project life) of a large oil spill during oil and gas activities.

As concluded by MMS, the effects would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact, the amount of oil spilled, the age/degree of weathering of the spilled oil at the time of contact, and whether the spill occurred in a "key habitat" as defined by McCauley et al (2000:698). The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. It is unlikely that whales would be likely to suffer significant population-level adverse effects from a large spill originating in the Chukchi Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. An oil spill probably would not permanently affect zooplankton populations, the bowhead's major food source, and the amount of zooplankton lost, even in a large oil spill, would be very small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993). The Chukchi Sea is considered to be one of multiple migratory pathways for bowhead whales moving to and from wintering habitat but is not considered to be a key habitat for bowhead whales such as used for feeding, calving, resting or breeding. As such it is unlikely that bowhead whales would incur significant population-level adverse effects as the result of a spill from the Devils Paw operation.

In March 2011, BOEM announced that they would undertake an analysis of a "Very Large Oil Spill" (VLOS) scenario as part of the Supplemental EIS (SEIS) in response to the *Deepwater Horizon* event. The analysis was conducted similar to the analyses in the Final EIS document, with the caveat that the release was the result of an unlikely event - a catastrophic blowout, (high volume) with a long duration and multiple trajectories. Discussion on the VLOS scenario is contained in Section IV.D.2, Appendix B and Appendix D of BOEM's Final SEIS (BOEM 2011). Effects of a VLOS on environmental resources are discussed in Section IV.E and are similar to the analyses conducted for a large spill in the BOEM Final EIS (MMS, 2007).

7.1 Potential Responses to Introduced Sounds

The possible effects of sound on marine mammals are highly variable. The magnitude of the effect depends on various factors, such as spatial relationships between a sound source and animal, hearing sensitivity of the animal, received sound exposure, duration of exposure, duty cycle, ambient sound level, the animal's activity at time of exposure, etc. The effects can roughly be categorized as follows (information based on Richardson et al. 1995b, Southall et al. 2007):

- *Hearing Impairment.* Intense sounds have the potential to cause an increased hearing threshold (poorer sensitivity) in animals that are exposed to that sound. This reduction in hearing sensitivity can result in a temporary threshold shift (TTS) or permanent threshold shift (PTS). Received sound levels must far exceed the animal's hearing threshold for there to be any TTS and even higher to risk PTS (probably at least 10 dB above the TTS threshold). Factors that influence the amount of hearing loss include the amplitude, duration, frequency, temporal pattern, content and energy contribution of noise exposure. High sound levels (e.g., pulsed sounds) can cause TTS during short sound exposures (seconds, minutes), while lower sound levels generally require longer exposures (hours, days). Considering the nature and duration of the activities, it is unlikely there would be any cases of temporary or especially permanent hearing impairment from the proposed activities.
- *Non-auditory physiological effects*. These effects might theoretically occur in marine mammals exposed to strong underwater sound and include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is unlikely that sounds from drilling, vessel and aircraft incur non-auditory physiological effects in marine mammals. Also, the airgun sounds generated during the VSP data acquisition runs are unlikely to incur non-auditory physiological effects in marine mammals, because the airguns will be operational for only a limited amount of time.
- *Disturbance.* Disturbance reactions can occur for nearly all types of sound exposures and are highly variable. Responses can range from subtle effects on respiration or other behaviors (detectable only by statistical analysis) to active avoidance reactions. The extent of disturbance reactions depends on a large variety of factors, of which the

context can be far more important than the sound level to which the animal is exposed. The magnitude of the response is also influenced by phenomena such as:

- o *Habituation.* Reduction in responsiveness after repeated or prolonged exposure to a sound. This happens most likely with sounds that are predictable in occurrence and characteristics, and associated with situations that the animal does not perceive as a threat.
- o *Sensitization.* Increase in responsiveness to sounds over time. Most cases of heightened responsiveness involve prior exposure to human activities that can be interpreted as severe and threatening.
- o *Tolerance.* Continued presence of marine mammals in areas with a certain degree of sound exposure, even though they might display short-term behavioral responses to that sound. Examples are the continued use of migration routes or feeding areas with heavy ship traffic. Most cases of tolerance may have developed via the habituation process, but the actual mechanism of tolerance is still unclear.

- *Masking.* Reduction of the ability of marine mammals to hear natural sounds. Any anthropogenic sound strong enough to be heard has the potential to mask biologically important sounds, including calls from conspecifics or predators, echolocation sounds, and environmental sounds such as ice or surf noise.

The potential effects of sounds from the proposed exploration drilling activities include behavioral disturbance, masking of natural sounds, and theoretically, temporary or permanent hearing impairment and non-auditory physical effects (Richardson et al. 1995b). The available literature on potential impacts of sounds on marine mammals frequently involves species that are not present in the planned project area, but those papers are included for completeness with information on whether the conclusions or inferences are relevant to the planned activities.

7.2 Sound Sources from the Proposed Activity

The extent to which the potential responses as described below will occur during the proposed activity is very much dependent on the sound sources that will be used. This section briefly summarizes the characteristics of sound sources of the proposed operation, i.e., drilling sounds, vessel sounds (including management of ice), aircraft sounds, and VSP airgun sounds.

7.2.1 Drilling Sounds

The main contributors to the underwater sound levels from jack-up rig drilling activities are the use of generators and drilling machinery. Few underwater noise measurements exist from operations using a drill rig. Here we summarize the results from the drilling rig *Ocean General* and its two support vessels in the Timor Sea, Northern Australia (McCauley 1998) and the jack-up rig Spartan 151 in Cook Inlet, Alaska (MAI 2011). For comparison, we also have included information on drilling sound measurements from a concrete drilling island and drill ship.

McCauley (1998) conducted measurements under three different conditions: (a) drilling rig sounds without drilling, (b) actively drilling, with the support vessel on anchor, and (c) and drilling with the support vessel loading the rig (McCauley 1998). The primary noise sources from the drill rig itself were from mechanical plants, fluid discharges, pumping systems and miscellaneous banging of gear on the rig. The overall noise level was low (117 dB re 1μPa at 410 ft [125 m]), mainly because the deck of the rig was well above the waterline (which is also the case for jack-up rigs). When the rig was actively drilling, the drill rig noise dominated the drilling sounds to a distance of about 1,312 ft (400 m). Beyond that distance the energy from the drill string tones (in the 31 and 62 Hz 1/3 octaves) became apparent and resulted in an increase in the overall received noise level. With the rig drilling the highest noise levels encountered were of the order of 117 dB re 1µPa at 410 ft (125 m) and 115 dB re1µPa at 1,228 ft (405 m). The noise source that far exceeded the previous two was from the support vessel standing alongside the rig for loading purposes. The thrusters and main propellers were engaged to keep the vessel in position and produced high levels of cavitation noise. The noise was broadband in nature, with highest levels of 137 dB 1µPa at 1,328 ft (405 m) and levels of 120 dB 1µPa at 1.8-2.4 mi (3-4 km) from the well head.

Acoustic measurements of the drilling rig Spartan 151 were conducted to report on underwater sound characteristics as a function of range using two different systems (moored hydrophone and real time system). Both systems provided consistent results. Primary sources of rig-based underwater sounds were from the diesel engines, mud pump, ventilation fans (and associated exhaust), and electrical generators. The loudest source levels (from the diesel engines) were estimated at 137 dB re 1 µPa @ 1 m (rms) in the 141-178 Hz ⅓ octave band. Based on this estimate the 120 dB (rms) re 1 µPa sound pressure level would be at about 154 ft (50 m) away from where the energy enters the water (jack-up leg or drill riser).

Hall and Francine (1991) measured drilling sounds from an offshore concrete island drilling structure. Source sound pressure level was 131 dB re 1µPa at 1 m for the drilling structure at idle (no drilling), and a transmission loss rate of 2.6 dB per doubling of distance, slightly less than theoretical cylindrical spreading. At a distance of 912 ft (278 m) from the drilling island the broadband sound pressure level was 109 dB re 1µPa. Strong tonal components at 1.375-1.5 Hz were detected in the acoustic records during drilling activities. These were likely associated with the rotary turntable, which was rotating between 75 and 110 rpm (which corresponds to 1.25-1.83 Hz). The received broadband sound pressure level at 849 ft (259 m) was 124 dB re 1µPa. The sounds measured from the concrete drilling island were almost entirely (>95%) composed of energy below 20 Hz.

Sound pressure levels of drilling activities from the concrete drilling island were substantially less than those reported for drill ships (Greene 1987a). At a range of 557 ft (170 m) the 20-1000 Hz band level was 122-125 dB for the drillship *Explorer I*, with most energy below 600 Hz (although tones up to 1850 Hz were recorded). Drilling activity from the *Explorer* was measured as 134 dB at a range of 656 ft (200 m), with all energy below 600 Hz. Underwater sound measurements from the drillship *Kulluk* at 3,215 ft (980 m) were substantially higher (143 dB re 1µPa). Underwater sound levels recorded from the drill ship Stena Forth in Disko Bay, Greenland, corresponded to measurements from other drill ships and were higher than sound levels reported for semi-submersibles and drill rigs (Kyhn et al. 2011). The broadband source levels were similar to fast moving merchant vessel with source levels up to 184-190 dB re 1 µPa during drilling and maintenance work, respectively. At a range of 1,640 ft (500 m) from the drill ship the 10-1000 Hz band level during drilling at 295 ft (90 m) ranged from approximately 100-128 dB re1 µPa, with the highest sound level at 100 and 400 Hz. Sound levels were ≤110 dB re1 µPa at 1.2 mi (2 km) distance.

Expected sound pressure levels for the proposed drilling activities have been modeled by JASCO Applied Research, Inc. for drilling sounds only and for drilling sounds in combination with the proximity of a support vessel using dynamic positioning. The acoustic modeling results show that the maximum radii to received sound levels of 120 and 160 dB re 1 µPa from drilling operations alone are 689 ft (210 m) and <33 ft (10 m), respectively (O'Neill et al. 2011). More detailed results are included in Attachment A of this IHA application.

7.2.2 Vessel Noise

In addition to the drill rig, various types of vessels will be used in support of the operations including ice management vessels, anchor handlers, supply vessels and oil-spill response vessels. Like other industry-generated sound, underwater sound from vessels is generally most apparent at relatively low frequencies (20–500 Hz). The noise characteristic of each vessel is unique depending upon propulsion unit, machinery, hull size and shape. These characteristics change with load, vessel speed and weather conditions. For example, increase in vessel size, power and speed produces increasing broadband and tonal noise. The noise produced by vessels is generated by engine machinery and propeller cavitation. When a vessel increases speed, broadband noise from propeller cavitation and hull vibration becomes dominant over machinery noise. It has been estimated that propeller cavitation produces at least 90% of all ship generated ambient noise (Ross 2005). Noise from large vessels is generally higher at low frequencies. Small high-powered (>100 horse power [HP]) propeller driven boats often exceed large vessel noise at frequencies above 1 kilohertz (kHz).

Ice management vessels operating in thick ice require a greater amount of power and propeller cavitation and hence produce higher sound levels than ships of similar size during normal operation in open water (Richardson et al. 1995b). Roth and Schmidt (2010) examined ice management vessel sound pressure levels during different sea ice conditions and modes of propulsion. Comparison of source spectra in open water and while breaking moderate ice showed increases as much as 15 dB between 20 Hz and 2 kHz. For low frequencies a sound pressure level of about 193 dB re 1µPa at 1 m was estimated to be a reasonable peak value.

Numerous measurements of underwater vessel sound have been performed since 2000 (for review see Wyatt 2008) mostly in support of industry activity. Results of underwater vessel sounds that have been performed in the Chukchi and Beaufort Seas were reported in various 90-day and comprehensive reports since 2007 (e.g., Aerts et al. 2008, Hauser et al. 2008, Brueggeman et al. 2009a, Ireland et al. 2009). Due to the highly variable conditions under which these measurements were conducted, including equipment and methodology used, it is difficult to compare source levels (i.e., back calculated sound levels at a theoretical 1 m from the source) or even received levels between vessels. For example, source sound pressure levels of the same tug with barge varied from 173 dB to 182 dB re 1µPa at 1 m, depending on the speed and load at the time of measurement (Zykov and Hannay 2006). Sound pressure levels of a drill rig support vessel traveling at a speed of about 11 knots (20 kph) was measured to be 136 dB re 1µPa at 1,312 ft (400 m) (McCauley 1998). Acoustic measurements of an anchor handling support tug of similar size and horsepower traveling at 4.3 knots (8 kph) resulted in sound pressure levels of approximately 137 dB re1µPa at 1,312 ft (400 m) and 120 dB re 1µPa at 4,855 ft (1,480 m) (Funk et al. 2008).

7.2.3 Aircraft Noise

Helicopters will be used for personnel and equipment transport to and from the drill rig. Over calm water away from shore, the maximum transmission of rotor and engine sounds from helicopters into the water can generally be visualized as a 26º cone under the aircraft. The size of the water surface area where transmission of sound can take place is therefore generally larger with a higher flight altitude, though the sound levels will be much lower due to the larger distance from the water. In practice, the width of the area where aircraft sounds will be received is usually wider than the 26º cone and varies with sea state, because waves provide suitable angles for additional transmission of the sound. In shallow water, scattering and absorption will limit lateral propagation. Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present. Because of Doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away. Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer.

Underwater sounds were measured for a Bell 212 helicopter (Greene 1982, 1985, Richardson et al. 1990). These measurements show that there are numerous prominent tones at frequencies up to about 350 Hz, with the strongest measured tone at 20–22 Hz. Received peak sound levels of a Bell 212 passing over a hydrophone at an altitude of ~1,000 ft (300 m), varied between 106-111 dB re 1µPa at 29 and 59 ft (9 and 18 m) water depth. Two Class 1 or Group A type helicopters will fly to and from the jack-up rig for transportation of manpower and supplies. Helicopters will be operated by a flight crew of two and capable of carrying 12 to 13 passengers.

7.2.4 VSP Airgun Sounds

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. Most energy emitted from airguns is at relatively low frequencies. Typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain significant energy up to 500–1000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007). Studies in the Gulf of Mexico have shown that the horizontally-propagating sound can contain significant energy above the frequencies that airgun arrays are designed to emit (DeRuiter et al. 2006; Madsen et al. 2006; Tyack et al. 2006). Energy at frequencies up to 150 kHz was found in tests of single 60-in^3 and 250-in^3 airguns (Goold and Coates 2006). Nonetheless, the predominant energy is at low frequencies.

The strengths of airgun pulses can be measured in different ways, and it is important to know which method is being used when interpreting quoted source or received levels. Geophysicists usually quote peak-to-peak (p-p) levels, in bar-meters or (less often) dB re 1 µPa. Peak level (zero-to-peak [0-p]) for the same pulse is typically ~6 dB less. In the biological literature, levels of received airgun pulses are often described based on the average or rms level, where the average is calculated over the duration of the pulse. The rms value for a given airgun pulse is typically ~10 dB lower than the peak level, and 16 dB lower than the peak-to-peak value (Greene 1997; McCauley et al. 1998, 2000). A fourth measure that is increasingly used is the Sound Exposure Level (SEL), in dB re 1 µPa^{2}s. Because the pulses, even when stretched by propagation effects (see below), are usually <1 s in duration, the numerical value of the energy is usually lower than the rms pressure level. However, the units are different.

Because the level of a given pulse will differ substantially depending on which of these measures is being applied, it is important to be aware which measure is in use when interpreting any quoted pulse level. NMFS refers to rms levels when discussing levels of pulsed sounds that might harass marine mammals; these are the units used in this IHA application. Specifics about the VSP airgun(s) and expected radii of various received rms sound levels are included in the acoustic modeling report of JASCO Applied Sciences (Attachment A of this IHA application). The VSP airgun operations differ from normal marine seismic surveys in that the airguns are fixed to one location (the drill rig), and a limited number of shots will be fired (a total of about 2 hrs of airgun activity per well, not including time required for ramp ups).

7.3 Potential Impact from Proposed Activity

The possible impacts of the proposed offshore exploration drilling project on marine mammals will mainly be related to sounds generated by the drilling rig, supply and support vessels (including ice management), aircraft, and VSP airguns. Responses of marine mammals to these sounds might include: tolerance and habituation, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995b). Based on the information provided below, it is, however, highly unlikely that there would be any cases of temporary or especially permanent hearing impairment, and non-auditory physical effects from the proposed activities.

7.3.1 Tolerance and habituation

Numerous acoustic studies have shown that underwater sounds from industry activities are often detectable in the water at distances of many miles from the source. Available data on behavior responses of marine mammals to these industrial activities have shown to be highly variable and context-specific. In most cases, the context in which the animal(s) is(are) exposed to a certain sound appears to be more relevant in determining the response than the sound level (Southall et al. 2007). Various studies have shown that marine mammals at distances of more than a few kilometers away often show no apparent response to different types of industry activities. This occurs even in cases when, based on measured received levels and known hearing sensitivity, the sounds must have been audible to the animals. One interpretation of the lack of any detectable behavior reaction is that the animals are habituated to the sound or tolerate the sound. This happens most likely in situations where marine mammals may have no alternative but to occupy areas where they will be exposed to noise, e.g., preferred feeding grounds, breeding areas, migration routes, etc.

The size of the area exposed to sound levels generated by the drilling rig that can elicit behavior responses (which is 120 dB re 1µPa for continuous sounds) is small (radius of 670 ft [210 m] around drill rig). The radius of the 120 dB sound level is 5 mi (8 km) when the support vessel holds position alongside the rig during rig supply. During VSP airgun operations the distance to received sound levels of 160 dB re 1µPa (the criteria for level B harassment form pulsed sounds) is 3 mi (5 km). The rig supply and VSP data acquisition runs are, however, short in duration. It does not seem likely that tolerance or habitation will occur as in most cases the animals are able to avoid the areas exposed to certain sound levels or the duration is too short for tolerance or habituation to occur. An exception may be pinnipeds associated with ice floes that could be present within the exposed areas, although this scenario is not likely to occur as drilling activities will cease when large ice floes are present in the area.

7.3.2 Masking

Any anthropogenic sound strong enough to be heard by marine mammals has the potential to mask biologically important sounds, including calls from conspecifics or predators, echolocation sounds, and environmental sounds such as ice or surf noise. This is especially the case if industrial sounds are of similar frequencies as the sounds of interest to marine mammals.

Sound generated by drilling activities, support vessels, ice management vessels, and VSP airguns contains most of its energy in the low frequency bands (up to 500 Hz). The sounds most important for communication to small odontocetes, and to a lesser extent large odontocetes and seals, are predominantly at much higher frequencies. Masking during the proposed activities is therefore considered to be negligible for these species. Mysticetes are known to be low frequency callers, so industrial sounds could affect their communication. However, studies conducted offshore of Northstar Island show that bowhead whales continue calling in the presence of continuous industrial sounds such as, construction, maintenance, drilling and vessel sounds (Richardson 2008, Aerts and Richardson 2009, 2010). To compensate and reduce masking, some mysticetes may alter the frequencies of their communication sounds (Richardson et al. 1995b, Parks et al. 2007). Exploratory analyses revealed an indication that call duration of bowhead whales decreases in relation to vessel sounds (Blackwell et al. 2008). Bowhead whale calls are frequently detected in the presence of seismic pulses, although the number of calls detected may sometimes be reduced, possibly because animals moved away from the sound source or ceased calling (Blackwell et al. 2011).

Although masking by marine mammal species in the area may occur, masking effects are expected to be negligible given the low number of cetaceans expected to be exposed, in part due to avoidance behavior of (see Section 7.3.3 below) and the fact that seals (most likely to be present in the area) are not very vocal during the open water period. Also, most sound generating activities (support vessel attending the rig on dynamic positioning, ice management, VSP airgun operations) are temporary in nature.

7.3.3 Disturbance Reactions

Behavioral responses of marine mammals to sound are highly variable, due to the many factors that influence their response. In many cases, the acoustic properties of the sound and the contextual variables might be of more relevance than the received sound level alone. For example, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (i.e., calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds. In addition, animals could react differently due to their age, gender, reproductive status, hearing capabilities and behavioral sensitivities to sounds due to prior conditioning, experience and current activities of those individuals (Southall et al. 2007).

Disturbance includes a variety of effects that can range from no response to more conspicuous changes in activities, and displacement. If a marine mammal reacts briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding, breeding or resting area for a prolonged period, impacts on the animals could be significant. The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by industrial sounds are based on behavioral observations during studies of several species. Detailed studies have been done on humpback, gray and bowhead whales, and on ringed seals.

Baleen Whales (Mysticetes)

Responses of baleen whales to non-pulsed sounds are quite variable. A review of a number of papers on this subject showed that in general, little or no response was observed in animals exposed at received levels from 90-120 dB re 1µPa. Probability of avoidance and other behavioral effects increased when received levels were 120-160 dB re 1µPa (Southall et al. 2007). Some of these papers, together with other available information, are summarized below.

Drilling Sounds

Studies on responses of bowhead and gray whales to playback sounds of drilling activities showed that both species begin to show detectable behavioral responses when received levels exceed 115–120 dB re 1 µPa (Malme et al. 1984, 1986, Richardson et al. 1990, 1995a). Malme et al. (1984) used playback sounds from drill ships, drill rigs and platforms to study behavioral effects on migrating gray whales and calculated 10%, 50%, and 90% probabilities of gray whale avoidance reactions at received levels of 110, 120, and 130 dB re 1µPa, respectively. Experiments using playback sounds of drilling (with estimated source levels 156 to 162 dB) were repeated to study effects on feeding gray whales (Malme et al. 1986). There was no clear evidence of any disturbance or avoidance of feeding gray whales at received levels of 110 dB re 1µPa, and possible avoidance for exposure levels approaching 119 dB re 1µPa. Malme recommended using 120 dB as the sound level at which 0.5 probability of avoidance can be expected, until more data would become available. Richardson et al. (1990) performed 12 playback experiments near Point Barrow in the Alaskan Arctic in which bowhead whales were exposed to drilling sounds during their spring migration. Whales generally did not respond to exposures in the 100 to 130 dB range, although there was some indication of minor behavioral changes in several instances. In another experiment where bowhead whales were exposed to playback of underwater sound from drilling activities, subtle behavioral effects that were temporary and localized occurred at distances up to 1.2-2.4 mi (2-4 km) from the sound source (Richardson et al. 1995a).

During offshore drilling operations in the Beaufort Sea, numerous sightings of marine mammals including bowhead whales were reported in the vicinity of the drill ship (Brewer et al. 1993, Hall et al. 1994). One bowhead whale sighting was recorded within ~1,312 ft (400 m) of a drilling vessel although other sightings were at much greater distances. Another study, introducing statistical techniques for spatial analyses of marine mammals using bowhead whale distribution data during drilling activities in the Beaufort Sea in 1993, showed that whales within a 30 mi (50 km) radius were farther away from the drilling rig than expected (Schick and Urban 2000). This analysis did not take into account potential responses from support vessels and aircraft attending to the rig. The received sound pressure levels at various distances from the rig were not measured, though sound levels during drilling were reported at >150 dB re 1µPa at 1 m. Analyses of whale call locations of migrating bowhead whales offshore Northstar, an oil production island in the Beaufort sea, showed that the southern edge of the whale call distribution moved slightly farther from shore (0.19 to 0.65 mi [0.31 to 1.05 km]) in response to operational sounds produced by Northstar (McDonald et al. 2012). The response was subtle and became apparent only after applying intensive, rather complex statistical analyses to the data. In some years, these responses were related to transient vessel sounds and in other years to the presence of specific tones (Richardson 2008). It is possible that the apparent deflection effect was, at least in part, attributable to a change in calling behavior rather than actual deflection. In either case, there would have been a behavioral response.

Vessel Sounds

Reactions of cetaceans to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement. As with other sound sources, responses to vessel approaches tend to be reduced if the animals are actively involved in a specific activity such as feeding or socializing (reviewed in Richardson et al. 1995b). Whales react most noticeably to erratically moving vessels with varying engine speeds and gear changes, and to vessels in active pursuit. Bowheads sometimes begin to swim actively away from approaching vessels when they come within 1.2–2.5 mi (2–4 km). If the vessel approaches to within several hundred meters, the response becomes more noticeable and whales sometimes change direction to swim perpendicularly away from the vessel path (Richardson et al. 1985, 1995a, Richardson and Malme 1993). Several studies have shown some avoidance behavior in humpback whales exposed to vessel sounds with received levels of about 110-120 dB, and clear avoidance at levels higher than 120 dB re 1µPa (Baker et al. 1982, McCauley et al. 1996). Similar results were found for minke whales in that minor changes in behavior (locomotion speed, direction and/or diving profile) were reported at received sound levels of 110 to 120 dB (Palka and Hammond 2001).

Especially at close distances, it is sometimes difficult to determine whether the whales react to the vessel sound or the physical presence of the vessel. During playback experiments where wintering humpback whales were exposed to sound levels between 120 and 130 dB re 1 µPa from a low-frequency signal in the 60 to 90 Hz band, most whales showed no measurable reaction. It seemed that the presence of the source vessel itself had a greater effect than did the low frequency sound playback (Frankel and Clark 1998).

Past experiences of the animals with vessels are important in determining the degree and type of response elicited from a whale-vessel encounter. This could have played a role in controlled exposure experiments where northern right whales were exposed to playbacks of vessel sounds and actual vessel sounds, an alert signal, and sounds from conspecifics (Nowacek et al. 2004). The whales reacted strongly to the alert signal, mildly to the social sounds, and no obvious response to sounds of approaching vessels or actual vessels. One possible reason for the lack of response could be that the whales might have habituated to vessel sounds, because the experiment was conducted in an area with heavy ship traffic. The habituation to vessel sounds and lack of response is in this particular case rather unfortunate as it increases the risk for collisions between the northern right whale and vessels.

Reactions of baleen whales to ice management vessels actively involved in breaking ice are expected to be stronger than would be seen during normal vessel operations. Playback sounds of ice management vessel sounds, however, showed that some bowheads appeared to divert from their migratory path but that others tolerated projected icebreaker sound at levels 20 dB and more above ambient sound levels (Richardson et al. 1995b). In this particular instance, the source level of the projected sound was much less than that of an ice management vessel actually breaking ice. Another limitation of the study was the inability of the sound projector to reproduce the low-frequency components (<45 Hz) of the recorded ice management vessel and drill rig sounds. Bowheads presumably can hear sounds extending well below 45 Hz, so whether the underrepresentation of low frequency sounds had significant effects on the responses by bowheads is not known.

Aircraft Sounds

Bowheads that were exposed to overflights of a Bell 212 helicopter and Twin Otter aircraft during their spring migration showed various behavioral responses. Most observed reactions occurred at flying altitudes of less than 492 ft (150 m; helicopter) and 597 ft (182 m; aircraft) and with lateral distances of less than 820 ft (250 m; Patenaude et al. 2002). More reactions resulted from exposure to helicopter activity than to fixed-wing aircraft. Because restrictions on helicopter altitude will be part of the mitigation measures during the proposed drilling activities, there will likely be little or no disturbance effects on baleen whales. If any disturbance would occur, it will be temporary and localized.

VSP Airgun Sounds

Baleen whale responses to pulsed sound, such as airguns, have been studied more thoroughly than responses to continuous sound. Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Baleen whale responses to pulsed sound may depend on the context, such as type of activity in which the whales are engaged at the moment of exposure. For example, some evidence suggests that feeding bowhead whales may be more tolerant of underwater sound than migrating bowheads (Miller et al. 2005, Lyons et al. 2009, Christie et al. 2010). Disturbance to baleen whales from VSP airgun sounds is unlikely to occur, due to the combination of low baleen whale density in the Devils Paw Prospect during the open water season and the short duration of airgun operations (total of two hrs of airgun activity per well, not including time required for ramp up procedures). If any disturbance would occur, it will be temporary and localized.

Most toothed whales have the greatest hearing sensitivity at frequencies much higher than that of baleen whales and they may be less responsive to low-frequency sound commonly associated with industry activities. Southall et al. (2007) reviewed field and laboratory studies that documented responses of toothed whales with best hearing in mid-frequency ranges exposed to non-pulse sounds. No clear conclusion could be drawn about received levels coincident with various behavioral responses. For example, some animals in the field showed obvious behavioral responses to exposures from 90 to 120 dB re 1µPa, while others did not show any responses for exposure to received levels from 120 to 150 dB re 1µPa. Contextual variables other than received level, and differences between species, are very likely reasons for this variability. In addition, the fact that captive subjects were often directly reinforced with food for tolerating noise exposure, created great disparity in results from field and laboratory conditions. Exposures in captive settings generally exceeded 170 dB before inducing behavioral responses.

Drilling Sounds

Beluga whales in the Alaskan Arctic showed avoidance behavior when exposed to playback sounds of a semi-submersible drillship with source levels of 163 dB re 1µPa at 1m (Awbrey and Stewart 1983). These avoidance reactions occurred at 0.2 and 0.9 mi (0.3 and 1.5 km) and at a distance of 2.2 mi (3.5 km) groups approached the sound. Received levels at these distances were estimated to range from 110 to 145 dB re 1µPa, assuming a 15 log R transmission loss. In a similar experiment, where beluga whales were exposed to playback sounds of a drilling platform with source levels of about 163 dB re 1µPa, no obvious reactions were observed (Richardson et al. 1990). In this experiment, aerial observations were conducted over an area of several hundred meters to several kilometers from the sound source. Moderate changes in movement were noted for three groups swimming within 656 ft (200 m) of the sound projector. Beluga whales did not show any apparent reaction to playback of underwater drilling sounds at distances greater than 656-1,312 ft (200-400 m; Richardson et al. 1995a). Reactions included slowing down, milling or reversal of course after which the whales continued past the projector, sometimes within 164-328 ft (50-100 m). The authors concluded (based on a small sample size) that playback of drilling sound had no biologically significant effects on the spring migration routes of beluga whales near Pt. Barrow.

Vessel Sounds

Of 17 groups of beluga whales approaching within a few hundreds (and sometimes tens) of meters of a projector playing underwater ice management vessel sounds, at least six appeared to alter their migration path in response to those sounds (Richardson et al. 1995b). At these distances, received levels at frequencies below 1 kHz were high, but below the hearing threshold at corresponding frequencies. However, beluga whales could probably hear, at least faintly, higher frequency components of the projected sounds, around 5 kHz. Received ice management vessel sounds levels in the 1/3-octave band centered at 5 kHz were 78-84 dB re 1 µPa, or 8-14 dB above ambient in that band. Distances over which belugas may be able to detect ice management vessel noise were estimated for different frequency bands and associated hearing thresholds (Cosesn and Dueck 1993). Detection distance ranged from 91-328 ft (28 to 100 m)) for 50 Hz (and hearing threshold of 139 dB re 1µPa) to 180-787 ft (55-240 m) for 5 kHz (and hearing threshold of 67 dB re 1µPa). The ability to detect a sound does, of course, not automatically result in a response. However, belugas appear to respond to actual ice management vessels at relatively large distances. Belugas and narwhals congregated near ice edges reacted to the approach and passage of ice management vessels at distances ranging from 12-50 mi (20 to 80 km; LGL and Greeneridge 1986). Reactions included fleeing at speeds of up to 12 mph (20 km/h)), abandoning normal pod structure and modifying vocal behavior. Narwhals, in contrast, generally demonstrated a “freeze” response, lying motionless or swimming slowly away (as far as 22 mi [37 km] down the ice edge), huddling in groups and ceasing sound production. There was some evidence of habituation and reduced avoidance 2 to 3 days after onset. Finley et al. (1990) reported beluga avoidance of actual ice management vessel activities in the Canadian High Arctic at distances of 21-31 mi (35 to 50 km). In addition to avoidance, changes in dive behavior and pod integrity were also noted. Using a software model, the zone around ice management vessels affecting beluga whale behavior was estimated to be in the order of 21-48 mi (35–78 km), depending on location (Erbe and Farmer 2000). These modeled distances are very similar to the distances at which belugas were observed to react (LGL and Greeneridge 1986, Finley et al. 1990). Opportunistic visual and acoustic monitoring of sperm whales in New Zealand exposed to nearby whale-watching boats (within 1,476 ft [450 m]) showed that sperm whales respired significantly less frequently, had shorter surface intervals, and took longer to start clicking at the start of a dive (Gordon et al. 1992). Broadband source levels were ~157 dB re 1µPa over a bandwidth of 100 Hz to 6 kHz. Received levels at 1,476 ft (450 m) were ~104 dB re 1µPa. Morton and Symonds (2002) used census data on killer whales in British Columbia to evaluate avoidance of non-pulse acoustic harassment devices (AHDs). Avoidance ranges were about 2.4 mi (4 km). There was also a dramatic reduction in the number of days “resident” killer whales were sighted during AHD-active periods compared to pre- and post-exposure periods and a nearby control site. Williams and Ashe (2007) tested experimentally whether killer whales responded differently to approach by few (1–3) versus many (43) vessels found that swimming paths became more tortuous when few boats approached whales, but straighter as many boats approached.

Finally, some recent papers deal with effects related to changes in marine mammal vocal behavior as a function of variable background noise levels. Foote et al. (2004) found increases in the duration of killer whale calls over the period from 1977 to 2003, during which time vessel traffic in Puget Sound, and particularly whale-watching boats around the animals, increased dramatically. Another study in Puget Sound showed that killer whales increased their call amplitude by 1 dB for every 1 dB increase in background noise levels (Holt et al. 2008). Calls and background levels were measured in the frequency band of 1-40 kHz, and nearby vessel counts were positively correlated with observed background noise levels. Belugas in the St. Lawrence River were also observed to increase the levels of their vocalizations as a function of the background noise level (the "Lombard Effect"; Scheifele et al. 2005). Dolphins whistled more often at the onset of vessel approaches compared to during and after vessel approaches or when no vessels were present (Buckstaff 2004). Whistles from Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) showed a shift in frequency composition when exposed to vessel sounds with broadband received sound levels of approx. 128 dB re 1µPa in the 1-22 kHz band. Dolphins exposed to lower vessel sound levels (approx. 108 dB broadband) didn't show this shift (Morisaka et al. 2005). It is important to note that these studies mainly concern small recreational watercrafts that generally exceed noise from larger vessels, such as those used in the proposed activity, at frequencies above 1 kHz.

Aircraft Sounds

Patenaude et al. (2002) reported that beluga whales appeared to be more responsive to aircraft overflights than bowhead whales. Changes were observed in diving and respiration behavior and some whales veered away when a helicopter passed at 820 ft (250 m) lateral distance at altitudes up to 492 ft (150 m). However, some belugas showed no reaction to the helicopter. Belugas appeared to show less response to fixed-wing aircraft than to helicopter overflights.

VSP Airgun Sounds

Toothed whales are categorized in the functional hearing groups of mid- and high-frequency cetaceans (Southall et al. 2007), with best hearing sensitivities generally at frequencies of more than 1 kHz. Although, airgun arrays emit most energy at 10–120 Hz, the pulses contain significant energy up to 500–1000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007; see also Section 7.2.4). Toothed whales have been observed to show avoidance behavior to airgun sounds. Aerial surveys conducted in the southeastern Beaufort Sea during summer found that sighting rates of beluga whales were significantly lower at distances closer to an operating airgun array (Miller et al. 2005; Harris et al. 2007). The harbor porpoise was observed to display avoidance behavior during airgun operations at received sound pressure levels of <145 dB re 1 µPa rms at a distance >43 mi (70 km) from the source (Bain and Williams 2006). Similarly, during seismic surveys with large airgun arrays off the U.K. in 1997–2000, there were significant differences in directions of travel by harbor porpoises during periods when the airguns were shooting vs. silent (Stone 2003; Stone and Tasker 2006). Impacts from airgun sounds generated by the VSP data acquisition runs to toothed whales are not likely to occur since toothed whales are not very common in the area and the duration of airgun operations is short (about 2 hrs total per well, not counting time required for ramp up procedures).

Pinnipeds

Pinnipeds generally seem to be less responsive when exposed to industrial sound than most cetaceans. The limited data describing responses of pinnipeds to non-pulse underwater sound suggest that exposures between ~90 and 140 dB re 1µPa generally do not appear to induce strong behavioral responses (see review of studies in Southall et al. 2007). There is no data regarding exposures at higher levels. It is important to note that among pinniped studies there are some apparent differences in responses between field and laboratory conditions. In contrast to mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field. Again, contextual issues are the likely cause of this difference. Below a summary of some findings related to pinniped responses to non-pulse sounds.

Pinniped responses to underwater sound from some types of industrial activities such as seismic exploration appear to be temporary and localized (Harris et al. 2001, Reiser et al. 2009b). Ringed seals showed also little or no reaction in response to pile-driving activities during construction of the Northstar Island in the Beaufort Sea (Blackwell et al. 2004). Construction sounds were likely audible at distances <1.8 mi (3 km) underwater and 0.3 mi (0.5 km) in air. Ringed seals were observed swimming as close as 150 ft (46 m) from the island. Ringed seal densities on ice in the vicinity of Northstar did not change significantly before and after construction and drilling activities (Moulton et al. 2003).

Harbor seals exposed to sounds from AHDs that were deployed around aquaculture sites were observed to be generally unresponsive to these sounds (Jacobs and Terhune 2002). During two specific events, individuals came within 141-144 ft (43-44 m) of active AHDs and failed to demonstrate any measurable behavioral response. The estimated received levels based on the measures provided were ~120 to 130 dB re 1µPa. Experiments with captive harbor seals showed responses at lower levels (Kastelein et al. 2006). Nine captive harbor seals in a ~82 x 98 ft (25 × 30 m) enclosure were exposed to non-pulse sounds used in underwater data communication systems (similar to acoustic modems). Test signals were frequency modulated tones, sweeps, and bands of noise with fundamental frequencies between 8 and 16 kHz. Source levels were ranging from 128 to 130 [± 3] dB and signal duration was 1 to 2 seconds. Seal positions and the mean number of individual surfacing behaviors were recorded during control periods (no exposure), before exposure, and in 15-min experimental sessions (n = 7 exposures for each sound type). Seals generally swam away from each source at received levels of ~107 dB and avoiding it by ~16 ft (5 m). Seals did not haul out of the water or change surfacing behavior and their reactions did not appear to wane over repeated exposure (i.e., there was no obvious habituation). The colony of seals generally returned to baseline conditions following exposure. The seals were not reinforced with food for remaining in the sound field.

Costa et al. (2003) measured received noise levels from an Acoustic Thermometry of Ocean Climate (ATOC) program sound source off northern California using acoustic data loggers placed on translocated elephant seals. Subjects were captured on land, transported to sea, instrumented with archival acoustic tags, and released such that their transit would lead them near an active ATOC source (at 3,080 ft [939-m] depth; 75-Hz signal with 37.5- Hz bandwidth; 195 dB max. source level, ramped up from 165 dB over 20 min) on their return to a haul out site. Received exposure levels of the ATOC source for experimental subjects averaged 128 dB (range 118 to 137) in the 60- to 90-Hz band. None of the instrumented animals terminated dives or radically altered behavior upon exposure, but some statistically significant changes in diving parameters were documented in nine individuals. Translocated northern elephant seals exposed to this particular non-pulse source began to demonstrate subtle behavioral changes at ~120 to 140 dB re 1µPa (rms) exposure.

VSP Airgun Sounds

Reactions of pinnipeds to noise from open-water seismic explorations have not been very well documented in the published literature. Gotz and Janik (2011) conducted experiments with wild-caught grey seals (*Halichoerus grypus*). They exposed the seals to repeated underwater noise pulses of 170 dB re µPa while they were retrieving fish from an underwater feeder. Five of seven seals tested showed startle responses to the pulse. All five of those that startled showed sensitization and avoidance of the exposure site in subsequent tests. Gotz and Janik (2011) conducted a follow-up experiment that determined the startle threshold at between 155 dB and 160 dB re µPa, although two animals did not react even at 180 dB re µPa. Visual monitoring from seismic vessels in the Chukchi and Beaufort Seas has shown only slight avoidance behavior in pinnipeds, if any responses occurred at all. Ringed seals do not frequently avoid the area within a few hundred meters of operating airgun arrays (Harris et al. 2001, Moulton and Lawson 2002, Miller et al. 2005). It is possible that seals in proximity of the drill rig, may show avoidance behavior during VSP airgun activity. If such reactions would occur they are expected to be local and of short duration.

7.3.4 Hearing Impairment and Other Physical Effects

The terms TTS and PTS are used to describe the upward shift in hearing threshold that can occur after exposure to loud noise. TTS or PTS is a possibility when marine mammals are exposed to very strong sounds. Existing data for marine (and terrestrial) mammals indicates that hearing damage is related both to the level and to the duration of the exposure. .

Non-auditory physical effects might also occur in marine mammals exposed to strong underwater sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation and other types of organ or tissue damage.

As discussed in more detail below, there is no definitive evidence hearing impairment or non-auditory physical effects occur even for marine mammals in close proximity to industrial sound sources. During the proposed project, it is unlikely marine mammals will be exposed long enough for these types of effects to occur given the following reasons:

- The proposed drilling activities, including support vessel on dynamic positioning, and ice-management activities, will not generate sound levels high enough or long enough to cause hearing impairment or non-auditory injury.
- The maximum radii to received sound levels of 180 and 190 dB from airgun sounds during the VSP data acquisition runs are estimated to be 0.6 mi [920 m] and 525 ft [160 m], respectively. However, these activities are too short in duration for hearing impairment or non-auditory physical effects to occur.
- Avoidance responses from many cetaceans will reduce the likelihood of exposure to sound levels that could potentially cause hearing impairment or non-auditory physical effects.
- Most cetaceans are migrating through the area of the proposed activities and the expected brief duration of exposure makes it unlikely for hearing impairment to occur due to prolonged exposure to lower sound levels.

The following subsections discuss in somewhat more detail the possibilities TTS, PTS, and non-auditory physical effects may occur.

Temporary Threshold Shift

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends.

There is limited data available on sound exposures that elicit TTS in cetaceans. The Joint Industry Program E&P Sound and Marine Life has recognized this lack in knowledge and is supporting a TTS study on small cetaceans. More information can be obtained from the International Association of Oil & Gas Producers website (www.soundandmarinelife.org). Experiments have been conducted with bottlenose dolphins and beluga whales, exposed to single pulse and non-pulsed sounds for periods ranging from 1 second to 50 min (see review in Southall et al. 2007). There are no published data on TTS of other toothed whales and of baleen whales. Based on the limited information available, the 180 dB criterion for delphinids and belugas is probably quite precautionary, i.e., lower than necessary to avoid TTS.

For baleen whales, TTS is not expected to occur during the proposed activities. The main reason for this is that the estimated source level of the proposed drilling activities is lower than 180 dB re 1µPa (rms). Also, baleen whales (especially migrating bowheads) are expected to avoid drilling and vessel activities before being exposed to levels high enough for there to be any possibility of TTS.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran et al. 2002, 2005). Given the available data, the received level of a single seismic pulse might need to be ~210 dB re 1 µPa rms (~221– 226 dB p–p) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200–205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received energy. Source levels associated with drilling activities are much lower than those produced during seismic airgun activity and the airgun activity during the VSP data acquisition runs is short in duration.

Initial evidence from prolonged exposures to sound suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005, Ketten et al. 2001, cf. Au et al. 2000). For the harbor seal, which is closely related to the ringed seal, TTS onset apparently occurs at somewhat lower received energy levels than for odontocetes. More experiments to study the onset of TTS on Arctic pinnipeds are currently being conducted (Long Marine Lab, University of California Santa Cruz).

Permanent Threshold Shift

When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS. It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during the proposed exploration drilling project. Marine mammals are unlikely to be exposed to received levels strong enough to cause even slight TTS. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. In fact, even the levels immediately adjacent to the jack-up rig may not be sufficient to induce PTS, even if the animals remain in the immediate vicinity of the activity.

Non-auditory Physiological Effects

Non-auditory physiological effects such as stress, neurological effects, bubble formation and other types of organ or tissue damage can theoretically occur in marine mammals exposed to strong underwater sound. If any such effects do occur, they would probably be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is unlikely that during proposed activities any single marine mammal would be exposed to strong sounds sufficiently long for physiological stress to develop.

There is speculation that gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004, Arbelo et al. 2005, Fernández et al. 2005a, Jepson et al. 2005b). Jepson et al. (2003) first suggested a possible link between mid-frequency sonar activity and acute and chronic tissue damage that results from the formation *in vivo* of gas bubbles, based on the beaked whale stranding in the Canary Islands in 2002 during naval exercises. Fernández et al. (2005a) showed those beaked whales did indeed have gas bubble-associated lesions as well as fat embolisms. Fernández et al. (2005b) also found evidence of fat embolism in three beaked whales that stranded 62 mi (100 km) north of the Canaries in 2004 during naval exercises. Examinations of several other stranded species have also revealed evidence of gas and fat embolisms (e.g., Arbelo et al. 2005, Jepson et al. 2005a, Méndez et al. 2005). Most of the afflicted species were deep divers. Even if gas and fat embolisms can occur during exposure to mid-frequency sonar, there is no evidence that that type of effect occurs in response to the types of sound produced during the proposed exploration activities. Also, most evidence for such effects has been in beaked whales, which do not occur in the proposed survey area.

Available data on the potential for underwater sounds from industrial activities to cause auditory impairment or other physical effects in marine mammals suggest that such effects, if they occur at all, would be temporary and limited to short distances. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of the proposed activities, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur auditory impairment or other physical effects.

7.3.5 Strandings and Mortality

Marine mammals close to high-energy underwater sounds with rapid rise times, such as detonations of explosives, can be killed or severely injured. The auditory organs are especially susceptible to injury (Ketten et al. 1993, Ketten 1995). Underwater sound from drilling and support activities is less energetic and has slower rise times, and there is no evidence they can cause serious injury, death, or stranding.

7.4 Summary

Any marine mammal sighted from the drill rig, can be considered well within the acoustic envelope of the activity. Because the drill rig is a fixed structure, the marine mammals will initiate all approaches. Marine mammals exposed to sounds generated by the planned activities, including from vessels, helicopters, the VSP data acquisition runs, and the drill rig itself, may be subject to some level of behavioural disturbance or masking at variable distances from the activities, but likely limited to within a few miles (typically 1.2-2.9 mi [2-4 km] for vessels and <820 ft [250 m] for helicopters). No hearing impairment or non-auditory physiological effects are considered likely. Disturbance reactions, should they occur, would be short-term reactions that do not disrupt behavioral patterns in a potentially significant manner, and are therefore not expected to have a biologically significant impact on individuals or populations.

8. ANTICIPATED IMPACT ON SPECIES AVAILABILITY FOR 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, Bacon et al. 2009). 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.

8.1 Subsistence Resources

Marine mammals are legally hunted in coastal waters by Alaska Natives and represent between 60% and 80% of their total subsistence harvest. The species regularly harvested by subsistence hunters in and around the Chukchi Sea are bowhead and beluga whales; ringed, spotted, and bearded seals; walrus, and sometimes polar bears. The species that will be discussed in this section do not include walrus and polar bear, as they do not fall under 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 the villages of Point Lay (~90 mi [145 km]), Wainwright (~120 mi [193 km]), Point Hope (~175 mi [282 km]), Barrow (~200 mi [322 km]), and Kivalina (~225 mi [362 km]). Subsistence harvesting in Point Lay is relatively balanced between marine and terrestrial resources (BLM 2003). Until recently there was little or no bowhead whale harvesting by the community of Point Lay, so beluga whale and walrus harvests are of greater importance. As of 2008, Point Lay has a quota of one strike for bowhead whales and they have been successful in harvesting one whale in 2009 and again one in 2011. Marine subsistence activities around Point Lay take place from Punnuk Creek in the south northward to Ice Cape. While most activities are in nearshore waters, hunters do venture up to 25 mi (40 km) offshore.

The community of Wainwright will be used for permanent infrastructure support for the project. This village enjoys a diverse subsistence resource base that includes both terrestrial and marine resources. Marine subsistence activities are focused on the coastal waters from Icy Cape in the south to Point Franklin and Peard Bay in the north. The Kuk River lagoon system—a major marine estuary—is an important marine and wildlife habitat used by local hunters. Wainwright is situated near the northeastern end of a long bight that affects sea-ice conditions as well as marine resource concentrations (MMS 2007). Marine mammals generally account for more than 70% by weight of all subsistence resources harvested, although the amount and composition of the subsistence diet in Wainwright varies from year to year depending upon the availability of subsistence resources.

Point Hope residents also use a diverse subsistence resource base, harvesting approximately 60 different species, both terrestrial and marine, over the course of a year. Point Hope's marine subsistence activities take place on the sea ice, in leads, and in open water, depending on the season. Most activity takes place in nearshore waters. Marine resources are harvested in a broad area extending from Cape Thompson to the south to Ayugatak Lagoon in the north.

Barrow is the largest community on the North Slope. Although villagers have access to and use a large variety of terrestrial and marine subsistence resources, Barrow residents rely heavily on marine resources, among which the bowhead whale is the most important. Bowhead hunting occurs in both spring and fall; if the spring whale hunt is not very successful, then the remaining quota will be shifted to the fall season. Unused ‘strikes’ from other villages unsuccessful in landing whales during the spring are also often transferred to fall hunt in Barrow.

The community of Kivalina depends heavily on subsistence resources and data from 1992 and 2007 show that 100% of households use subsistence resources during the year with total harvests equaling 261,765 and 255,344 pounds of wild food, respectively (U.S. Environmental Protection Agency 2009), of which about 126,000 of the 255,344 pounds is from marine mammals (Magdanz et al. 2010).

In each of these villages, the most important bowhead and beluga whale hunting occurs during northward spring migration, although in the past few years the bowhead fall hunting has become increasingly important for the Chukchi villages.

8.1.1 Bowhead Whale

The bowhead whale is a critical subsistence and cultural resource to the Chukchi communities of Barrow, Wainwright, Point Lay and Point Hope, who rely on the harvest of these whales for cultural and nutritional needs. A quota system for hunting bowhead whales was established by the IWC in 1977. The quota is currently regulated through an agreement between NMFS and the AEWC. The AEWC allots the number of bowhead whales that each community is permitted to harvest. Some local hunters join bowhead whaling crews from other Chukchi villages. The bowhead hunt primarily takes place during spring migration (typically March through June), when bowheads are passing through leads in the nearshore ice in the Chukchi and Beaufort seas towards their summer feeding grounds in the Canadian Beaufort Sea. The spring bowhead hunt typically takes place from early April till the end of May (Bacon et al. 2009) and is conducted from the edge of the shore-fast ice using wood-framed boats made by hand out of bearded seal skin (umiak). Table 9 summarizes average number of bowhead whale landings by Barrow, Wainwright, Point Hope, and Kivalina over a 3-year period between 1974-1977 (prior to the establishment of quota by the IWC) and a 34-year period from 1978-2011 (after the establishment of quota by the IWC). Because whales must be taken in an ice-covered ocean, some of the struck whales inevitably slip under the ice, where they may be lost. The actual harvest area and quantity varies from year to year, depending mainly on where the leads open. In Point Hope the leads are rarely more than 6 to 7 mi (10 to11 km) offshore, but in some years hunters had to travel as far as 10 mi (16 km) away from the community to find open water(Bacon et al. 2009). Point Lay has not taken bowhead whales in past years due to no quota being allocated to the village, however in 2008 a single annual strike was awarded and one whale was harvested during the 2009 hunt and one during the 2011 spring hunt. Kivalina has four strikes allocated annually but the location of the village makes bowhead hunting difficult and between 1982-2005 only 7 bowhead whales were landed; in years where ice or weather conditions prohibit hunting, Kivalina has transferred its quota to Point Hope (MMS 2008).

Table 9 Average number (standard deviation) of Bowhead Whale Landings in the Chukchi Villages between 1974-1977 and 1978-2011 (quota were instituted in 1978 by the IWC). Source: Suydam and George, 2012.

Village	1974-1977 Average/Year	1978-2011 Average/Year
Barrow	15.5 (7.05)	15.5 (8.23)
Wainwright	1.5 (1.29)	3.1 (1.41)
Point Hope	6.3 (4.35)	2.6 (1.54)
Kivalina	0.3 (0.50)	0.21 (0.41)

Notes:
Point Lay landed its first whale in more than 70 years in 2009, and another one in 2011.

The fall bowhead hunt has always been more difficult as the whale migration routes do not always occur close to shore and high winds and rough seas often prevent the small whaling skiffs with outboard motors to go out at sea. However, in recent years the fall bowhead hunt has become increasingly important for the Chukchi communities (Wainwright had its first successful fall whale hunt in 2010 and again landed a whale in 2011). The fall hunt in the Chukchi Sea typically starts end of September or early October and continues until the quota has been reached or weather conditions prevent whaling activities. Subsistence fall hunting generally takes place within 30 mi (48 km) from shore, however, hunters have been reported traveling as far as 50 mi (80 km) offshore to pursue whales (Braund and Moorehead 1995).

COP's exploration drilling support vessels will travel through the whale migratory path from their anchoring location, 5 mi (8 km) offshore between Wainwright and Point Lay, and the drilling platform, located more than 60 mi (97 km) from the Chukchi Sea coastline. Arrival of the rig and vessels is anticipated around July 1, after the spring bowhead hunt. Demobilization in October could overlap with the fall bowhead whale hunt; COP will discuss all potential concerns with the AEWC and others prior to activities commencing (see COP *Plan of Cooperation*). Noise from COP's planned exploration drilling activities, including vessel and helicopter support travel, have the ability to potentially affect the path of migrating whales. Despite temporary displacement however, as explained in Section 7, the whales have generally been observed to resume their migratory route after they pass through areas of disturbance (Davis 1987, Brewer et al. 1993, Hall et al. 1994) and the area of disturbance from drilling activities is well beyond the distance that can be safely traversed by the hunters.

8.1.2 Beluga Whale

Beluga whales are a highly valued subsistence resource for the Chukchi communities, mainly for purposes of consumption. Like the bowhead hunt, subsistence beluga whaling occurs mainly during spring migration (typically from early April through the end of June) when the whales pass through ice leads on their way north. However, in some years belugas are being hunted as late as mid-July. Point Hope crews typically harvest whales a week earlier than Barrow, where intensive hunting begins in the last week of April (Bacon et al. 2009). Beluga whales remain in coastal waters and lagoons through June and often times into July and August. Because they tend to remain relatively close to shore, whale hunts for belugas tend to take place within a few miles of shore. Communities most heavily dependent on beluga whales as a resource are Point Lay and Point Hope. Hunters in Point Hope take two-thirds of their belugas during the spring bowhead hunt, and the remainder during the summer in near-shore waters to the east of Point

Hope and at the mouth of the Kukpuk River near Sinuk (Bacon et al. 2009, MMS 2008). From 1990-2005, hunters from Point Hope, Point Lay, Wainwright and Kivalina harvested an average of 31, 44, 10, and 5, respectively (MMS 2006, Bacon et al. 2009). The mean annual number of belugas harvested from the eastern Chukchi Sea stock from 2002-2006, was 59 animals (Allen and Angliss 2010). Planned activities will take place well offshore and are not expected to impact the beluga harvest. For vessel movements in nearshore areas, such as the alternate drill rig staging area or presence of oil spill reponse vessels, COP will consult with the communities on measures to mitigate potential impacts on subsistence hunting.

8.1.3 Ice Seals

Ice seals (ringed, spotted and bearded seals) are all extremely important subsistence resources. In addition to meat for human consumption, they also provide fur for clothing, skins for whaling boats (bearded seal), bones for tools as well as arts and crafts, and the meat can also serve as food for village sled dogs. The meat from seals is often traded between communities for other necessary goods and services.

The number of seals taken annually varies considerably between years due to ice and wind conditions, both of which impact hunter access to seals. Because these seals haul out on ice, hunters are more likely to be able to access their habitat and be successful in harvesting these animals. Table 10 summarizes average annual harvest rates for ice seals.

Ringed Seal

Making up the bulk of subsistence seal harvest, ringed seals are mainly harvested in the Chukchi Sea from late March through July, however they can be hunted year round. Cracks in the ice and open leads where ringed seals haul out are the most common areas that subsistence hunters use to harvest seals. Detailed harvest information is not available, but as of August 2000, the estimated total annual harvest from 129 villages throughout various Alaskan regions was 9,567 (Allen and Angliss 2010). This estimate was based on data gathered from 1990 to 1998, and from the 1980s for 16 villages. Because COP exploration drilling activities are located far offshore, exploration drilling activities are expected to have little or no effect on subsistence harvesting of ringed seals. Planned vessel and helicopter support will avoid areas used by hunters, following discussions with community representatives.

Spotted Seal

Most subsistence harvest of the spotted seal is conducted by the communities of Wainwright and Point Lay during the fall (September and October), when spotted seals migrate back to their wintering habitats in the Bering Sea (USDI/BLM 2003). Spotted seals are also occasionally hunted in the area off Point Barrow and along the barrier islands of Elson Lagoon to the east (USDI/BLM 2005). Data on subsistence harvest levels is not available for all communities in the region (Allen and Angliss 2010). Data for 2000-2004 provides an estimated annual harvest of 37 spotted seals for five communities (Little Diomede, Gambell, Savoonga, Shishmaref and Wales). Statewide, the best available annual harvest of spotted seals is estimated at 5,265 (Allen and Angliss 2010). This number is derived from the ADFG database containing spotted seal information of 135 villages gathered in the 1980s (for 16 villages) and 1990-1998. . Planned activities are offshore of the coastal harvest area used for spotted seals, thus conflicts with harvesting are not anticipated. COP will coordinate all planned activities, including vessel and helicopter transit routes with community representatives.

Bearded Seal

Bearded seals are an important resource because their skins are often used for boats, shelters and clothing. While bearded seals can be hunted year round in the Chukchi Sea, they are harvested primarily in spring during breakup of the ice (Bacon et al. 2009). Bearded seals are generally hunted while hauled out on nearshore sea ice using small boats. As of August 2000, the best available annual subsistence harvest estimate based on data from the Division of Subsistence of ADFG is 6,788 bearded seals by 129 villages throughout entire Alaska (Allen and Angliss 2010). This data was derived from various sources based on surveys conducted in the 1980s and 1990-1998. The total average harvest of bearded seals by eight North Slope villages from 1994-2003 was estimated at 1314.3 (Bacon et al. 2009) of which 1290.8 from the villages of Barrow, Wainwright, Point Lay and Point Hope. Most bearded seals are harvested in nearshore waters, thus impacts attributable to planned activities offshore are not anticipated. As stated previously, COP will coordinate all planned activities, including vessel and helicopter transit routes with community representatives.

Table 10 Average[1] Annual Take of Marine Mammals other than Bowhead Whales Harvested by the Communities of Point Lay, Wainwright and Barrow

Villages[2]	Beluga Whales	Ringed Seals	Bearded Seals	Spotted Seals
Point Lay	31	49	13	53
Wainwright	8	86	74	12
Barrow	2	394	175	4

Notes:
1 Includes one or more harvests from 1987-1999 (Braund et al. 1993; USDI/BLM 2003, 2005)
2 No information from Point Hope and Kivalina available

8.2 Anticipated Impact

Proposed exploration drilling activities will take place between mid-July and October of 2014. As described in Section 2, the project area is located ~120 mi (193 km) west of Wainwright, the village used for permanent infrastructure to the project. Approximate distances from the project area to other villages along the Chukchi coast are 200 mi (322 km) for Barrow, 90 mi (145 km) for Point Lay, 175 mi (282 km) for Point Hope, and 225 mi (362 km) from Kivalina. Potential impact from these activities is expected mainly from sounds generated by vessel and helicopter traffic. Due to the timing of the project and distance from shore, it is anticipated to have negligible or no effects on the bowhead and beluga whale spring hunts.

Proposed project activities during the open water season could potentially affect occasional summer harvests of beluga whales, subsistence seal hunts, and the fall bowhead hunt. However, due to the anticipate sound levels generated in combination with the large distance from hunting areas, the proposed exploration drilling activities are expected to have little or no effects on the success of these subsistence harvests.

The exploration activities will be supported by land based operations located in Wainwright. Air support will provide manpower and supply needs once the rig is on location. It is possible that aircraft and some of the vessel traffic will occur closer to shore. During rig mobilization conditions might require the rig to be offloaded in the alternate staging area south of Kivalina. To facilitate communications with the villages, COP will establish a central communication station (Com-Station) located at Wainwright and communication outposts in Pt. Hope, Pt. Lay, and Barrow. The Com-Station and outposts will be equipped with VHF radios, GPS receivers, and satellite phones. Communication outposts may also be established and manned in other villages, such as Kivalina and Kotzebue, if project activities will occur near subsistence hunting activities from these villages. A communication representative may also be present in Wales and St. Lawrence Island during mobilization and demobilization activities if subsistence activities are occurring. The outposts will communicate via radio or land line to the Com-Station operator in Wainwright.

COP has prepared a Plan of Cooperation (POC) to meet the requirements of 50 CFR 216.104(12), identifying what measures have been or will be taken to mitigate potential impacts on subsistence harvesting. COP will continue to meet with communities as a part of the POC.

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.

COP's planned drilling project will not result in any permanent impact on habitats used by marine mammals or to their prey sources. The main potential impacts on marine mammal habitat from the planned operations are: (1) elevated sound levels from drilling activity and vessel operations, (2) seafloor disturbance and increased turbidity, and (3) physical ice management.

9.1 Potential Impact on Habitat from Elevated Sound Levels

Elevated sound levels can result in avoidance of habitat by marine mammals or their prey. As described above in Section 7.3.3, avoidance reactions for many migrating cetaceans and seals, if it occurs, will be of short duration and limited to a relatively small area around the jack-up rig.

There is no available information directly pertaining to sound detection by zooplankton (Payne 2004). It is most likely that zooplankton detect only the particle displacement component (i.e., mechanical disturbances of water molecules) of underwater sound. Since they lack air-filled body spaces, it is unlikely that they can detect the pressure component of sound, hence elevated sound levels from the proposed activities are not expected to have an impact on zooplankton. With respect to prey species of seals and toothed whales, it has recently been well established that operating offshore platforms both attract and produce fish (Love et al. 2003, Neira 2005), and that they can serve as a refuge for many fish species. So, although sounds generated by drilling activities and associated vessel support are within the frequency range detectable by most fish, it doesn't necessarily mean that fish will avoid the exposed area. It is generally believed fish avoid vessels because of the noise they generate (Mitson and Knudsen 2003, Handegard et al. 2003), although there is no agreement about the magnitude of the avoidance effect (Gerlotto et al. 2004). The responses of fish to vessels may vary between species with different motivations (e.g., depending on trophic level), and motivation may vary with time, e.g., being related to spawning (Skaret et al. 2005). In some cases, fish were observed to be attracted and swimming towards vessels or vessel traffic lanes (Handegard and Tjøstheim 2005, Røstad et al. 2006). Evidently, the response of fish to vessels is also not a simple mechanical avoidance reaction to auditory stimuli. Based on available information, we believe it is unlikely the proposed drilling activities and associated vessel traffic will affect fish species as prey resource of seals and odontocetes in the project area.

9.2 Potential Impact on Habitat from Seafloor Disturbance and Discharges

9.2.1 Seafloor Disturbance

Seafloor disturbance would occur with bottom founding of the drill rig legs and anchoring system and also with the anchoring systems of support vessels. These activities can lead to direct effects on bottom fauna, through either displacement or mortality. Increase in suspended sediments from seafloor disturbance has also the potential to indirectly affect bottom fauna and fish. The amount and duration of disturbed or turbid conditions will depend on sediment material and consolidation of specific activity.

Placement of the drill rig onto the seabed will include firm establishment of its legs onto the seafloor. No anchors are required to be deployed for stabilization of the rig. Displacement or mortality of bottom organisms will occur in the area covered by the spud can of the legs. The area of seabed that will be covered by these spud cans is about 2,165 ft^2 or 200 m^2 per spud, which is a total of 6,500 ft^2 or 600 m^2 for three legs or 8660 ft^2 or 800 m^2 for four legs. The mean abundance of benthic organisms in the Klondike area was about 800 individuals/m^2 (Blanchard et al. 2010) and consisted mostly of polychaete worms and mollusks. The drill rig is a temporary structure that will be removed at the end of the field season. Benthic organisms are expected to decolonize the relatively small disturbed patches from adjacent areas. Any impact on marine mammals from seafloor disturbance is anticipated to be negligible.

Placement and demobilization of the drill rig can lead to an increase in suspended sediment in the water column, with the potential to affect zooplankton, including fish eggs and larvae. The magnitude of any impact strongly depends on the concentration of suspended sediments, the type of sediment, the duration of exposure, and also of the natural turbidity in the area. Fish eggs and larvae have been found to exhibit greater sensitivity to suspended sediments (Wilber and Clarke 2001) and other stresses than adult fish, which is thought to be related to their relative lack of motility (Auld and Schubel 1978). Sedimentation could potentially affect fish by causing egg morbidity of demersal fish feeding near or on the ocean floor (Wilber and Clarke 2001). However, the increase in suspended sediments from drill rig placement, demobilization and anchor handling is very limited, localized and temporary, and will be indistinguishable from natural variations in turbidity and sedimentation. No impacts on zooplankton are therefore expected considering the high inter-annual variability in abundance and biomass in the Devils Paw Prospect, influenced by timing of sea ice melt, water temperatures, northward transport of water masses, nutrients and chlorophyll (Hopcroft et al. 2011).

9.2.2 Discharges

Drilling muds and cuttings discharged to the seafloor can lead to localized increased turbidity and increase in background concentrations of barium and occasionally other metals in sediments and may affect lower trophic organisms. Drilling muds are composed primarily of bentonite (clay) and the toxicity is therefore low. Heavy metals in the mud may be absorbed by benthic organisms, but studies have shown that heavy metals do not bio-magnify in marine food webs (Neff et al. 1989). There have been no field monitoring studies of effects of water-based muds and cuttings discharges on biological communities of the Alaskan Chukchi Sea, and only a few in the development area of the Alaskan Beaufort Sea (Neff et al., 2010). However, the results of these studies are consistent with the results of many more comprehensive microcosm and ecological investigations near WBM and cuttings discharge sites in cold-water environments of the North Sea, the Barents Sea, off Sakhalin Island in the Russian Far East, and in the Canadian Beaufort Sea off the Mackenzie River (Neff et al. 2010). All the studies show that water-based muds and cuttings discharges have no, or minimal and very short-lived effects on zooplankton communities. This might, in part, be due to the large interannual differences observed in the planktonic communities. In the Chukchi Sea the interannual variability of zooplankton biomass and community structure is influenced by differences in ice-melt timing, water temperatures, and the northward rate of transport of water masses, nutrients and chlorophyll (Hopcroft et al. 2011). Effects on benthic communities are minor and nearly always restricted to a zone within about 100 to 150 m of the discharge, where cuttings accumulations are greatest; this is the area where there should be the highest density of drilling monitoring sampling stations.

9.3 Physical Management of Ice

Based on extensive satellite data analyses of historic and present ice conditions in the northeastern Chukchi Sea, it is unlikely that hazardous ice will be present in the vicinity of the jack-up rig. COP therefore expects that physical management of ice will not be required. However, to ensure safe drilling operations COP has developed an *Ice Alerts Plan* designed to form an integral part of the drilling operations. The Ice Alerts Plan contains procedures that will allow early predictions of advance of potential hazardous ice that could cause damage if it were to come into contact with the jack-up rig.

The first method of prevention is to identify the presence of hazardous ice at a large distance from the rig (tens of miles). The ice edge position will be tracked in near real time using observations from satellite images, and from vessels. Generally, the ice management vessel will remain within 5.5 mi of the drill rig, unless deployed to investigate migrating ice floes. When investigating ice, vessels will likely not travel farther than 75 miles from the rig. The Ice Alerts Plan contains procedures for determining how close hazardous ice can approach before the well needs to be secured and the jack-up moved. This critical distance is a function of rig operations at that time, the speed and direction of the ice, the weather forecast and the method of ice management.

Based on available historical and more recent ice data, there is low probability of ice entering the drilling area during the open water season. However, if hazardous ice is on a trajectory to approach the rig, the ice management vessel will be available to respond. One option for responding is to use the vessel's fire monitor (water cannon) to modify the trajectory of the floe. Another option is to redirect the ice by applying pressure with the bow of the ice management vessel, slowly pushing the ice away from the direction of the drill rig. At these slow speeds the vessel uses low power and slow propeller rotation speed, thereby reducing noise generation from propeller rotation effects in the water. In case the jack-up rig needs to be moved due to approaching ice, the support vessels will tow the rig to a secure location.

Because it is unlikely that sea ice will be present in the project area at the time of operations and the ice management alert system is implemented to prevent ice from approaching the rig too close, no physical management of ice is expected to occur, and no damage to marine mammal habitat is anticipated. However, this application is based on the possibility of up to 72 hrs of physical ice management. If a potentially hazardous ice floe (to operations) is identified and the floe contains ice seals, COP will notify the NMFS representative immediately and seek guidance. The potential physical management of ice by redirecting its trajectory away from the rig would have a temporary, negligible impact on marine mammal habitat.

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.

As outlined in Section 9, the only direct loss of habitat is from the seabed area covered by the spud cans of the jack-up rig legs. The total area is about 2,165 ft^2 or 200 m^2 per spud, which is a total of 6,500 ft^2 or 600 m^2 for three legs or 8660 ft^2 or 800 m^2 for four legs. Benthic organisms inhabiting this area will be displaced or smothered. However, due to the limited area and duration of the proposed drilling project, and because Klondike is mainly characterized as a pelagic system (Day et al. 2012) with a low density of benthic feeding marine mammals, the limited loss or modification of habitat is not expected to result in impacts to marine mammals or their populations. See Section 9 for more details on the anticipated impact on habitat essential to marine mammal species in the Chukchi Sea.

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.

COP's planned exploration drilling project will incorporate operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The pre-season modeling of acoustic footprints of various drilling related activities was conducted to guide mitigation at the design and planning stage. Based on current knowledge, the drilling activities, including movements of support vessels will not lead to injury of marine mammals, such as a temporary reduction in hearing sensitivity or permanent hearing damage. Monitoring of exclusion zones is therefore not applicable during drilling. The distance at which received sound levels occur that have the potential for behavioral disturbance (120 dB rms for continuous sounds) are 689 ft (210 m) for drilling only and about 5 mi (8 km) for drilling and support vessel activity (O'Neill et al. 2011). Protected species observers at the drill rig will monitor this zone, using big eye binoculars, documenting presence and behavior of marine mammals during these activities. During these activities, the rig and vessel operators will adhere to the general mitigation measures listed in the following subsection. No specific mitigation measures will be established.

During the planned VSP data acquisition runs, received sound levels can increase to levels that have the potential to cause auditory injury to marine mammals. The distance to received levels of 190 dB and 180 dB re 1µPa during these activities are estimated to be 525 ft and 3,018 ft (160 m and 920 m), respectively (O' Neill et al. 2011). This means that during VSP data acquisition runs, specific mitigation procedures, such as shutdown criteria, will be implemented in addition to the applicable general mitigation measures. Potential harassment will be estimated based on the 160 dB re 1µPa, which propagates out to distances of 3 mi (5 km). Proposed general and VSP-specific mitigation measures are summarized as follows.

11.1 General Mitigation Measures

- Avoid concentrations or groups[2] of whales. Operators of support vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.
- Reduce vessel speed to below 10 knots when within 0.2 mi (300 m) of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.
- Avoid multiple changes in direction and speed when within 0.2 mi (300 m) of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

[2] A concentration or group of whales is defined by the presence of three or more individuals within a 500 m area displaying behaviors of directed or coordinated activity.

- When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.
- Dedicatedprotected species observers (PSOs) will be present on the drill rig to monitor for presence of marine mammals within exclusion zones (during VSP data acquisition runs) and disturbance zones and have the authority to call for the implementation of mitigation measures when required by the situation.
- Fully implement all avoidance and mitigation measures outlined in the POC to avoid having an unmitigable adverse impact on the availability of marine mammals for taking for subsistence uses (see Section 12).
- Except in emergency situations, aircraft must maintain a 1,500-ft (457-m) minimum altitude within 0.5 mi (800 m) of groups or concentrations of whales. When weather conditions do not allow flights above this altitude, aircraft must avoid areas of known whale concentrations and avoid flying directly over or within 0.5 mi (800 m) of these areas.
- Helicopters may not hover or circle above areas with groups of whales or within 0.5 mi (800 m) of such areas.

11.2 Specific Mitigation Measures During VSP Data Acquisition Runs

- Initial distances to received sound levels of 190 and 180 dB (rms) produced by the VSP airguns have been estimated using an acoustic model (Attachment A of this IHA application). These modeled distances will be used to establish exclusion zones for the implementation of mitigation measures during the first VSP data acquisition run to prevent marine mammals from exposure to received levels of ≥190 dB (pinnipeds) and ≥180 dB (cetaceans). The exclusion zones might change for subsequent VSP data acquisition runs after the distances have been verified based on acoustic field measurements.
- During the VSP data acquisition runs, the PSOs will ensure that the 190 dB and 180 dB exclusion zones remain free of marine mammals for 30 min prior to commencement of the VSP run.
- The VSP data acquisition run will start during daylight hours.
- Ramp up, power down and shut down procedures will be followed as described below.

11.2.1 Ramp Up Procedure

Ramp up procedures of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number of operating airguns until the required discharge volume is achieved. The purpose of a ramp up (also referred to as soft start) is to alert marine mammals that might be in the vicinity of the airguns.

Ramp up will begin with the smallest airgun present. The precise ramp up procedure has yet to be determined. Unless otherwise agreed upon, COP intends to double the number of operating airguns at one-minute intervals. Since the airgun operation at each geophone station only lasts about one minute, the one-minute interval for ramp-up is considered adequate and also reduces the total emission of airgun sounds. During the ramp up, observers will scan the exclusion zone for the full airgun array for presence of marine mammals.

The ramp up procedures will be applied as follows:

- A ramp up at the start of each VSP data acquisition run can be initiated if the exclusion zone has been free of marine mammals for a consecutive 30-min period. The entire exclusion zone must be visible during this period. If the entire exclusion zone is not visible, then ramp up at the start of each VSP data acquisition run cannot be initiated.
- Ramp up procedures at the start of each VSP data acquisition run will be delayed if a marine mammal is sighted within the exclusion zone during the 30-min period prior to the ramp up. The delay will last until the marine mammal(s) has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 or 30 min. The 15 min applies for small toothed whales and pinnipeds, and the 30 min for baleen whales and large toothed whales.
- No ramp up of airguns will be conducted between one-minute airgun operations at subsequent geophone stations (i.e., following the relocation of the geophone within the wellbore) if; *(i)* the duration of the relocation is 30 min or less; *(ii)* the exclusion zone of the full array has been visible; and *(iii)* no marine mammals have been sighted in the applicable exclusion zone.
- No ramp up of airguns will be conducted between 1-minute airgun operations at subsequent geophone stations (i.e., following the relocation of the geophone within the wellbore) during poor visibility or darkness if one airgun has been operating continuously during the geophone relocation period.
- The seismic operator and PSOs will maintain records of the times when ramp-ups start, and when the airgun array reaches full power.

11.2.2 Power Down Procedures

A power down is the immediate reduction in the number of operating airguns such that the radii of the 190 dB (rms) and 180 dB (rms) zones are decreased to the extent that an observed marine mammal is not in the applicable exclusion zone. During a power down, one airgun (or some other number of airguns less than the full airgun array) continues firing. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of airgun activity, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.

- The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.
- If a marine mammal is sighted within or about to enter the applicable exclusion zone of the single mitigation airgun, it too will be shut down.
- Following a power down, operation of the full airgun array will not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone of the full array, or has not been seen within the zone for 15 min (pinnipeds or small toothed whales) or 30 min (baleen whales or large toothed whales).

11.2.3 Shut Down Procedures

The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the exclusion zone for which a power down is not adequate to reduce exposure to less than 190 dB (for seals) or 180 dB (for cetaceans).

Airgun activity will not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone as described above under ramp up and power down procedures.

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.

Implementing regulations of the MMPA at 50 CFR 216.104(a)(12) require IHA applicants for activities that take place in Arctic waters to provide a Plan of Cooperation (POC) or other information that identifies what measures have been taken and/or will be taken to minimize adverse effects on the availability of marine mammals for subsistence purposes. A similar requirement is set forth in Minerals Management Service (MMS)[3] Lease Sale 193 Stipulation Number 5.

COP has developed a POC intended to support operations related to COP's Chukchi Sea Exploration Project (the *Plan of Cooperation* Chukchi Sea Exploration Project: Devils Paw Prospect). The POC reflects COP's is commitment to communicating and cooperating with local communities to prevent and resolve conflicts with subsistence hunters during the offshore exploration project. COP has distributed the February 2012 POC version to representatives of the villages during community meetings organized by COP.

The POC sets out procedures for COP and contract staff to work in cooperation with the Chukchi Sea coastal communities through mutual sharing of information (e.g. project schedule, activity location/timing, etc) with the objective of preventing conflicts between the exploration program activities and subsistence hunting.

As set forth in the POC and elsewhere, COP will:

- Comply with all federal permits and authorizations and their respective stipulations, and other rules and regulations applicable to offshore exploration leases issued by the BOEM.
- Continue consultation with the directly affected Chukchi Sea subsistence communities as well as the North Slope Borough, and co-management entities such as the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Ice Seal Committee, and the Nanuuq Commission to discuss potential conflicts and mitigating measures that could be implemented to prevent unreasonable conflicts with subsistence activities.
- Restrict offshore exploration activities to the open-water season to reduce the number of potential interactions with subsistence activities and marine mammals.

[3] As part of a major reorganization the Minerals Management Service (MMS) was replaced by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE).

- Implement an industry-supported communications protocol with the Chukchi Sea coastal villages, which provides local residents with real-time information on specific activity and vessel movement locations.
- Work collaboratively with Wainwright to establish an onshore logistic support plan for COP offshore activities.
- Maintain a presence in Wainwright and Barrow during operations to work closely with the communities.
- Maintain communication in the Chukchi Sea communities (Wainwright, Pt. Lay, Pt. Hope, Barrow, Kivalina, and Kotzebue) by hosting open houses, participating in village and borough assemblies, and meeting with community leaders to share information concerning the COP Chukchi Sea Offshore Outer Continental Shelf Exploration Project activities.

The onboard Inupiat communicator will call in to the Communication Station (Com-Station) with information on marine mammal sightings and will receive information regarding hunting activities, allowing implementation of mitigation measures identified in the POC and in this IHA application. Through the use of a marine mammal observation program, an onboard Inupiat Communicator and coordination with the land-based Com-Station, it is the goal of the POC to prevent any adverse impacts to subsistence hunting.

COP has consulted, and will continue to consult, with the Chukchi Sea communities to keep residents informed about project activities and mitigate potential impacts. Prior to starting offshore activities COP will consult with Point Hope, Point Lay, Wainwright, Barrow, Kivalina and Kotzebue as well as the North Slope Borough, the Northwest Arctic Borough and co-management organizations recognized by the USFWS and the NMFS (i.e., AEWC, the Ice Seal Committee, the Alaska Beluga Whale Committee, the Eskimo Walrus Commission, and the Nanuuq Commission). COP will also engage in additional consultations with these groups on request. The discussions will include presentation of the POC, exploration project overview, identifying safeguards to prevent conflicts with subsistence hunting, and as necessary, an attempt to resolve any identified potential conflicts. The POC will be updated with any changes identified during this process and will distributed to all affected subsistence communities and NMFS, USFWS and BOEM as required.

Additional meetings (scheduled and opportunistic) and other communications will continue throughout project execution. In addition, public service announcements will be aired over the KBRW and KOTZ radio stations and Alaska Rural Communications Service television network during operations. Other announcements may be made through other media outlets as the project progresses. COP will also send reports of activities directly to each borough, city, tribe, and village corporation office in each community.

Post-season meetings will be held in each Chukchi Sea community and with co-management organizations to review performance of this POC, and to present monitoring information.

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.

COP proposes to sponsor marine mammal and acoustic monitoring during the drilling operations, in order to implement the proposed mitigation measures, and to satisfy the anticipated monitoring requirements of the USFWS LOA and NMFS IHA.

COP's proposed Marine Mammal Mitigation and Monitoring Plan (4MP) is described in detail in Attachment B of this IHA application. COP understands this Monitoring Plan will be subject to review by NMFS and others, and that refinements may be required. COP is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

14. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL HARASSMENT

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

COP remains open to cooperation 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 impacts related to the planned activities. Since 2006, COP has been cooperating with other operators in the northeastern Chukchi Sea, sharing resources and data where possible and applicable. COP considers the integration of research information vital in obtaining an increased understanding of the ecology of marine mammals and the environment that they inhabit. In 2008, COP initiated the Chukchi Sea Environmental Studies Program (CSESP) that has been ongoing, with co-funding from Shell and since 2010 also from Statoil. This is an ecosystem-based research program that includes research components such as physical oceanography, plankton, benthos, fish, sea birds and marine mammals (both visual and acoustic). This integrated program is intended to provide scientific data on multiple aspects of the Chukchi Sea environment and to help inform planning and decision making in future years.

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ATTACHMENT A

Acoustic Modeling of Underwater Noise from Drilling Operations at the Devils Paw Prospect in the Chukchi Sea

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Acoustic Modeling of Underwater Noise from Drilling Operations at the Devils Paw Prospect in the Chukchi Sea

Authors:
Caitlin O'Neill
Graham Warner
Andrew McCrodan

2012 November 16

JASCO Applied Sciences
Suite 2101, 4464 Markham St.
Victoria, BC, V8Z 7X8, Canada
Phone: +1.250.483.3300
Fax: +1.250.483.3301
www.jasco.com

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1. Introduction

ConocoPhillips plans to perform exploratory drilling and vertical seismic profiling (VSP) data acquisition runs during the open water season (July-November) of 2014 at the Devils Paw Prospect in the Chukchi Sea. The drilling will be conducted with a jack-up rig. JASCO Applied Sciences has been contracted to perform underwater acoustic modeling of the marine drilling operations to provide estimates of their noise footprints for use at evaluating potential effects on marine mammals.

The present modeling study considers noise from drilling activities performed by a jack-up rig and a single support vessel in dynamic positioning mode. Areas ensonified from these activities were estimated using JASCO Applied Sciences' Marine Operations Noise Model (MONM) at drillsite DP-5, within the Devils Paw prospect. The model results for each scenario are presented as sound level isopleth maps indicating the maximum sound level over depth for a region centered at the drillsite. Distances to sound level thresholds from 160 to 120 dB re 1 µPa in 10 dB steps are given for three scenarios, the first two of which are 1: jack-up drill rig alone, 2: drill rig and one support vessel holding position using its thrusters.

A third scenario considers VSP noise generated by a stationary medium-size airgun array deployed from the rig or a vessel. The proposed array is a 760 in^3 ITAGA airgun system. Acoustic source levels for this airgun system were computed using JASCO's AASM airgun array computer model and the sound footprints were subsequently computed using MONM.

2. Methods

2.1. Location

The exploratory well drilling operations are expected to be performed at site DP-5 within the Devils Paw Prospect during the 2014 open-water season. A support vessel was included as a noise source for one of the drilling modeling scenarios, as it maintains position alongside the drill rig. A modeling region of 50 km by 50 km (31 mi by 31 mi) was defined with the drillsite at its geometric center. The geographic location of the drillsite is listed in Table 1. This location and the modeling region are plotted in the map of Figure 1.

Table 1. Geographic coordinates and water depth at drillsite.

Sound Source	Water Depth (ft)	Latitude*	Longitude*	X (m)**	Y (m)**
Drillsite DP-5	37.5 m (123 ft)	165° 13' 51.464" W	70° 54' 57.911" N	491572	7868054

* Geographic coordinates in degrees, minutes, seconds WGS84; ** NAD83 UTM Zone 3N

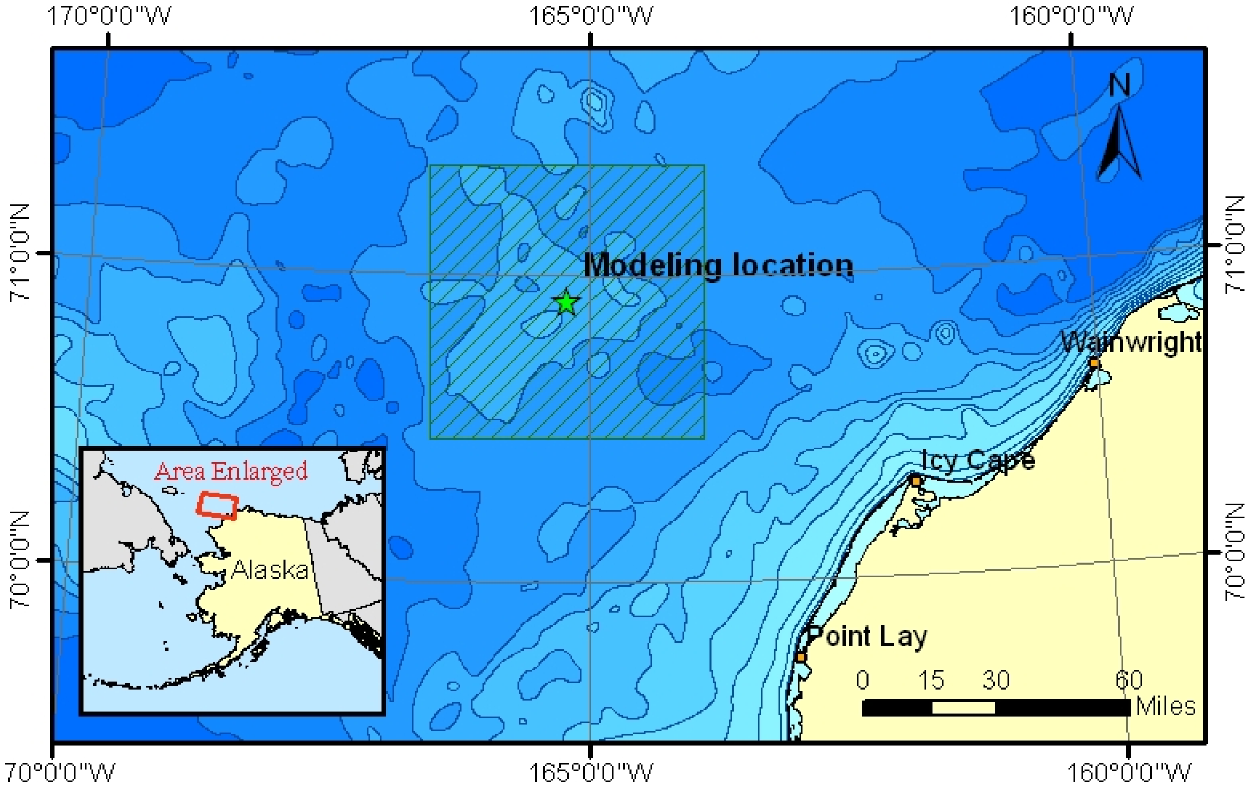

Figure 1. Map showing drillsite and modeling area (depicted by shaded box) in the Chukchi Sea.

2.2. Scenarios

The proposed drilling will be conducted with a jack-up rig.. Approximately four times a week, a support vessel will travel to the drill rig for resupply. Other vessels, including spill response vessels, will be positioned away from the drill rig, either anchored, idling or drifting depending on the weather conditions and are therefore not considered part of the drilling operation in terms of noise generation. They have therefore not been included in this noise modeling assessment. Three scenarios were considered for modeling:

1. Jack-up rig performing drilling operations alone (without support vessels attending the rig).
2. Jack-up rig performing drilling operations with the support vessel alongside the rig, maintaining position using thrusters.
3. 760 in^3 ITAGA airgun array operating at the drillsite.

2.3. Model Description

The acoustic propagation model used in this study is JASCO's Marine Operations Noise Model (MONM). MONM computes either received Sound Pressure Level (SPL) from continuous noise sources such as the drill rig and vessels, or per-pulse SEL from impulsive sources such as airgun arrays.

MONM treats sound propagation in range-varying acoustic environments through a wide-angled parabolic equation (PE) solution to the acoustic wave equation. The PE code used by MONM is based on a version of the Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for shear wave losses from elastic seabeds. The PE method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins, 1993).

MONM computes acoustic fields in three dimensions by modeling transmission loss along evenly spaced 2-D radial traverses covering a 360° swath from the source, an approach commonly referred to as N×2-D. The model fully accounts for depth and/or range dependence of several environmental parameters including bathymetry and sound speed profiles in the water column and the sea floor. It also accounts for the additional reflection loss that is due to partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces. It includes compressional and shear wave attenuations in all layers. The acoustic environment is sampled at a fixed range step along radial traverses.

MONM treats frequency dependence by computing acoustic transmission loss at the center frequencies of 1/3-octave bands between 10 Hz and 2 kHz. This frequency range includes the important bandwidth of noise emissions for the drill rig, vessel, and airgun array considered here. 1/3-octave band received levels are computed by subtracting band transmission loss values from the corresponding source levels. Broadband received levels are then computed by summing the received band levels. MONM's sound level predictions have been validated against other models and experimental data (Hannay & Racca, 2005).

<u>Model Input Parameters</u>

2.3.1. Water Sound Speed Profile

Water column sound speed profiles (SSPs) at the modeling site for each month of the proposed drilling schedule (July through November) were computed from temperature and salinity profiles from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM) database (Naval Oceanographic Office, 2003). GDEM provides historical average profiles that extend to the deepest depth in a given 15-arc-minute square.

Temperature-salinity profiles from GDEM were converted to SSPs using the equation of Clay and Medwin, 1977:

$$c(z,T,S) = 1449.2 + 4.6T - 0.055T^2 + 0.00029T^3 + (1.34 - 0.010T)(S - 35) + 0.016z$$

where *z* is depth in meters, *T* is temperature in degrees Celsius, and *S* is salinity in ppt.

The SSP for the month of November was selected for the purpose of this study because the implied propagation conditions at that time are more strongly upward-refracting. This environment is typically favorable for supporting longer-range underwater acoustic propagation and thus will produce more conservative results for effects assessment. SSP values for depths greater than 115 ft (35 m) were linearly extrapolated. Figure 2 shows the SSP at the modeling site for November derived from the GDEM data with extrapolated sound speeds shown in green.

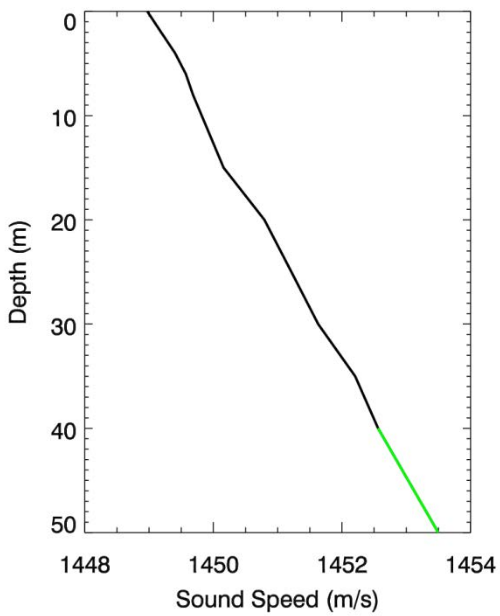

Figure 2. Sound speed profile at well site DP-5 obtained from the GDEM-V database for the month of November. Extrapolated sound speeds are shown in green.

2.3.2. Geoacoustics

Underwater sound propagation in shallow water is strongly influenced by the geoacoustic parameters of the sea floor. The important parameters include the density and the compressional and shear wave speeds, and attenuation coefficients of seabed layers. MONM takes all of these parameters into account when calculating transmission loss. For this modeling study the geoacoustic parameters were taken from location 2 in Zykov *et al.* (2010), where the parameters were derived from the analysis of previous sound source verification studies. This geoacoustic profile is thought to be conservative because it contains highly reflective layers. The table below gives the following parameters that were used in the model: density (ρ), compressional speed (V_P), compressional attenuation coefficient in decibels per wavelength (α_P), shear wave speed (V_S), and shear wave attenuation coefficient (α_S).

Table 2. Geoacoustic properties of the modeling area.

Depth (m)	ρ (g/cm^3)	V_P (m/s)	α_P (dB/λ)	V_S (m/s)	α_S (dB/λ)
0–1	1.87–2.08	1600–1700	0.5–0.54	200	1.1
1–5	2.08–2.2	1700–1800	0.54–0.72		
5–100	2.2	1800–2300	0.72–1.9		
>100	2.2	2300	1.9		

2.3.3. Bathymetry

Bathymetry data for the modeling area were obtained from the Global Integrated Topo/ Bathymetry Grid dataset (Lindquist *et al*., 2004). These data consist of topography and bathymetry information from three publicly available gridded datasets, sampled and merged into identically registered 30-s latitude/longitude grids. Latitude/longitude point bathymetry data for each modeling area were converted to Universal Transverse Mercator (UTM) Zone 3N coordinates and interpolated onto a regular *x*/*y* grid with 656 ft (200 m) resolution.

2.3.4. Estimating 90% rms SPL from SEL computed for VSP impulses

The MONM model predicts SPL for continuous sources such as drilling noise. It however computes the per-pulse sound exposure level (SEL) for airgun impulses. The metric used for take estimates is the 90% rms sound pressure level (SPL_{RMS90}). The SEL and rms metrics have different units but are numerically related according to a formula that depends on the rms integration period *T* containing 90% of the pulse energy flux density.

$$\mathrm{SPL}_{\mathrm{RMS90}} = \mathrm{SEL} - 10\log(T) - 0.458$$

Here the last term (0.458) accounts for the fact that only 90% of the acoustic pulse energy is delivered over the standard integration period used for computation of SPL_{RMS90}. While the conversion is simple in theory, in practice the pulse duration varies with distance from the source and depends on water depth and geoacoustic environment. The pulse duration and integration period can be modeled, but here we used the measured durations from previous airgun array sound measurements at nearby locations (O'Neill *et al.*, 2010; Mouy *et al.*, 2007) to derive a SPL – SEL conversion function. The resulting function, shown in Figure 3, contains a large near-field difference of 12 dB for ranges less than 1 km and then decreases with distance from the airgun array to just 0.3 dB at 70 km. At that distance 90% of the pulse energy flux density arrives approximately over 1 second.

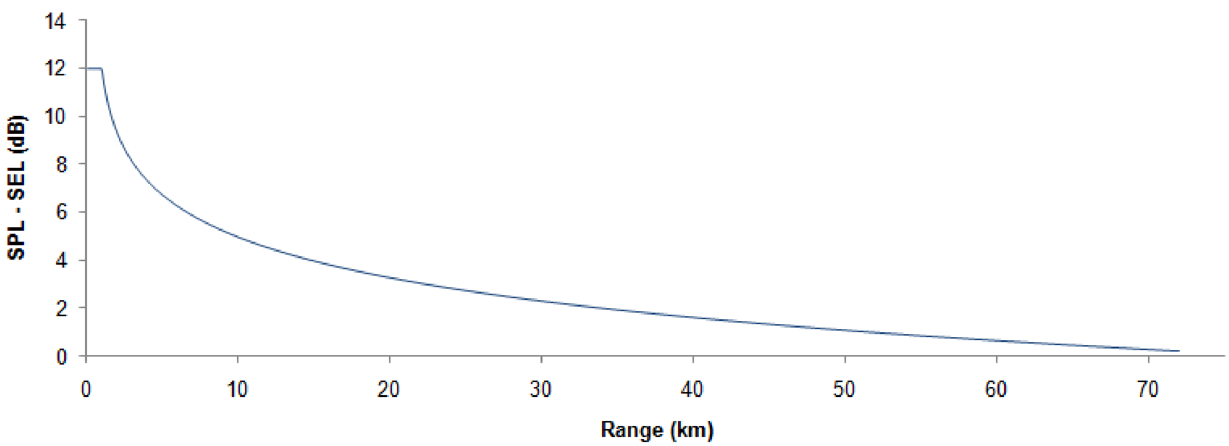

Figure 3. SEL to rms SPL conversion function applied to modeled VSP airgun SEL levels, based on previous airgun array sound measurements in the Chukchi Sea. The conversion is not required continuous vessel and drilling noise levels.

2.4. Source Levels

Acoustic source levels for the jack-up rig and support vessel on dynamic positioning (DP) were required for Scenarios 1 and 2 of this modeling study.Source levels were estimated based on measurements of a similar drill rig and support vessel available from literature. Source levels for the VSP scenario, using the 760 in^3 ITAGA airgun array, were predicted using JASCO's AASM model as described in section 2.4.3.

2.4.1. Drill Rig

Source level measurements from a fixed-leg drilling platform were used as surrogates for jack-up rig source levels because the operating structures are similar. Gales (1982) measured noise from drilling and combined drilling/production platforms. The transmission path from operating machinery to water of the fixed leg platforms monitored by Gale are similar to those for standard steel-legged jack-up rigs. None of the measured noise could be directly linked to the mechanical action of the drill bits, and little difference was seen between levels from drilling and levels from production, indicating that the actual drilling operation was not the dominant source of noise. Nevertheless, the measured spectra and tonal levels from the fixed-leg platform (likely including other sources of noise) were back-propagated using spherical spreading and converted to 1/3-octave band levels to calculate the source levels.

The resulting source levels were low relative to drillship sound measurements. This is attributed to the more-direct sound transmission path from the drillship machinery through the hull into the water. To be conservative and to account for the unknown relationship between sound levels of fixed-leg platforms and jack-up rigs, we added a safety factor of 10dB to the source levels of the fixed-leg platform. The resulting source levels for the derived jack-up drill rig are given in Figure 4. The tonal components exceed the 1/3-octave band levels at low frequencies and they strongly influence the broadband source level, which is 167 dB re 1 µPa@1m. The low frequency tones are however attenuated more rapidly by destructive surface reflection interference than mid-frequency sounds and they may not dominate the received sound field at distance from the rig. The source was modeled as a point source at mid-water depth.

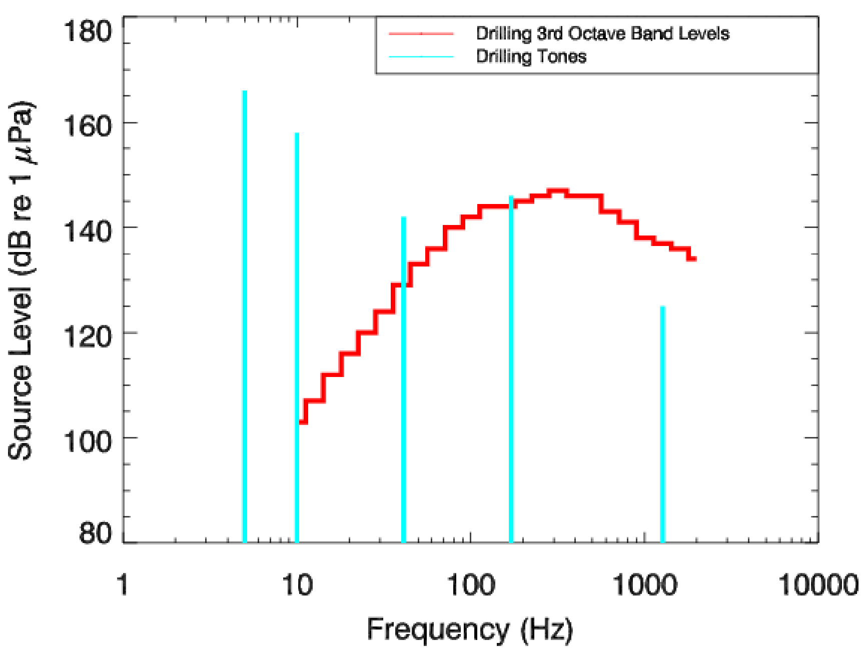

Figure 4. 1/3-octave band source levels and tones of the jack-up rig, calculated from measurements made by Gales (1982).

2.4.2. Vessel

To model sound levels for vessels similar to the support vessel on dynamic positioning, we used source level measurements made on a smaller vessel using thrusters and adjusted upward based on the ratio of propulsion system thruster power. The specifications for a representative support vessel and the surrogate vessel are given in Table 3. The total horsepower of thrusters on the proposed support vessel is 6000 HP; the corresponding horsepower of the surrogate vessel is 3000 HP. The power ratio of 2 might be expected to lead to a 3 dB acoustic sound level difference. We used a 6 dB adjustment to be conservative. The resulting source levels predicted for the support vessel are shown in Figure 5. The broadband source level of the surrogate vessel, computed by summing the 1/3-octave band levels, is 204 dB re 1 µPa, with much of this energy at frequencies below 20 Hz. All source modeling assumed a point source at 6 m (19.5 ft), which corresponds with the maximum vessel draft. The use of the deepest possible source depth is a conservative approach because destructive interference from surface reflections decreases with increasing source depth – resulting in lower received levels from deeper sources.

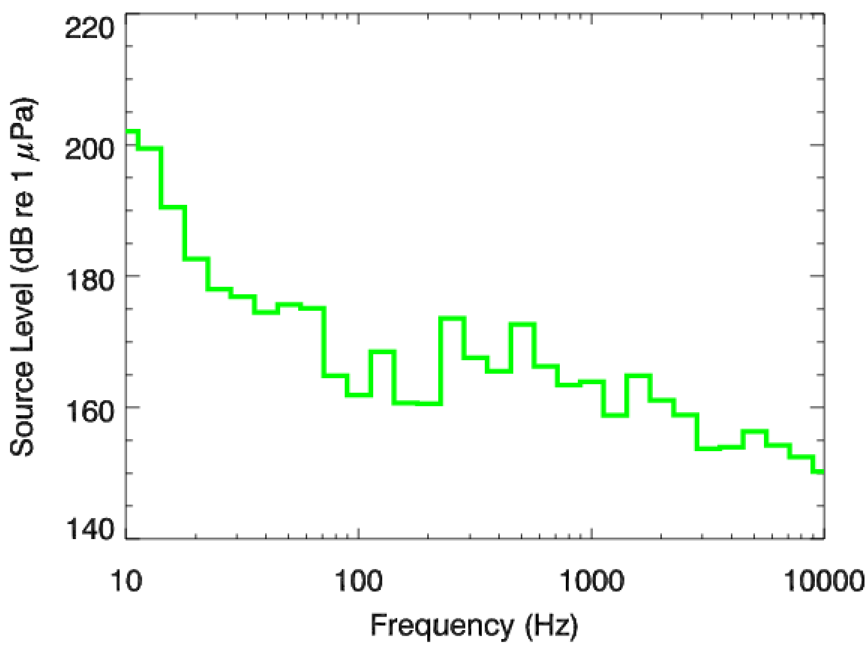

Figure 5. Derived source levels of the support vessel using dynamic positioning with thrusters, calculated from measurements made by JASCO.

Table 3. Comparison of the specifications of the proposed and surrogate vessels.

Parameter	Proposed Vessel	Surrogate Vessel
Length	381 ft	213 ft
Beam	72 ft	37.1 ft
Maximum Draft	19.5 ft	16 ft
Stern Propulsion	2 FPP* x 3000 HP, steerable	2 CPP** x 1300 HP
Thrusters	2 CPP** x 1500 HP tunnel thrusters 2 CPP** x 1500 HP drop-down azimuthing thrusters	2 FPP* x 1500 HP omni-directional thrusters

*Fixed pitch propeller; **Controllable pitch propeller

2.4.3. 760 in^3 ITAGA Airgun Array

The acoustic source level of the ITAGA airgun array was predicted with JASCO's Airgun Array Source Model, AASM (MacGillivray, 2000). AASM simulates the expansion and oscillation of air bubbles generated by an array of seismic airguns, accounting for pressure interaction between bubbles. It includes effects from surface-reflected pressure waves, heat transfer from bubbles to the surrounding water, and buoyant movement of the bubbles themselves. The model output is a collection of high-resolution airgun pressure signatures superimposed with the appropriate time delays to yield the overall array source signature in any direction. Third-octave band source levels for the array are obtained by filtering the far-field array signature into 1/3-octave pass bands.

Figure 6 shows the layout of the airgun array used for the modeling exercise, with four 40 in^3 guns and four 150 in^3 guns firing at 2000 psi. From this image it was estimated that each cluster of 4 was arranged in a 1 m x 1 m square, with 1.5 m between the two clusters. The nominal towing depth for this array is 3 m, which was taken as the depth of the top layer of airguns for the model input. Figure 7 shows the azimuthal directivity pattern and directional source levels at 1/3-octave band center frequencies.

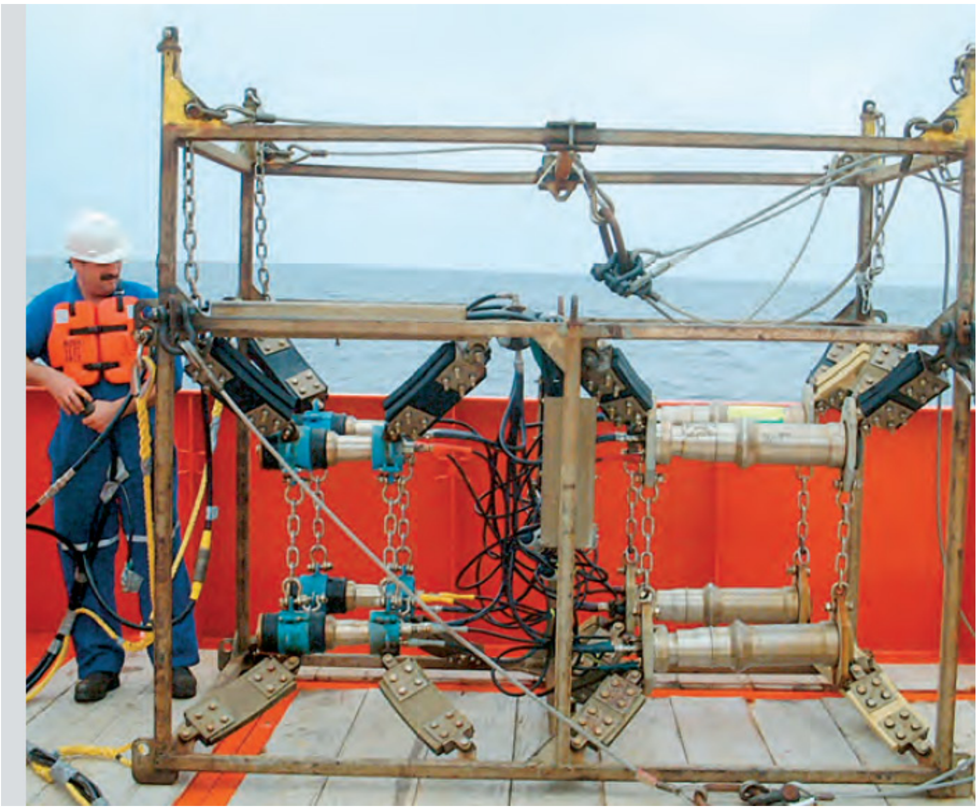

Figure 6. 760 in^3 ITAGA airgun array. Photograph from Schlumberger's Offshore Borehole Seismic Sources brochure (SMP-4101, September 2002).

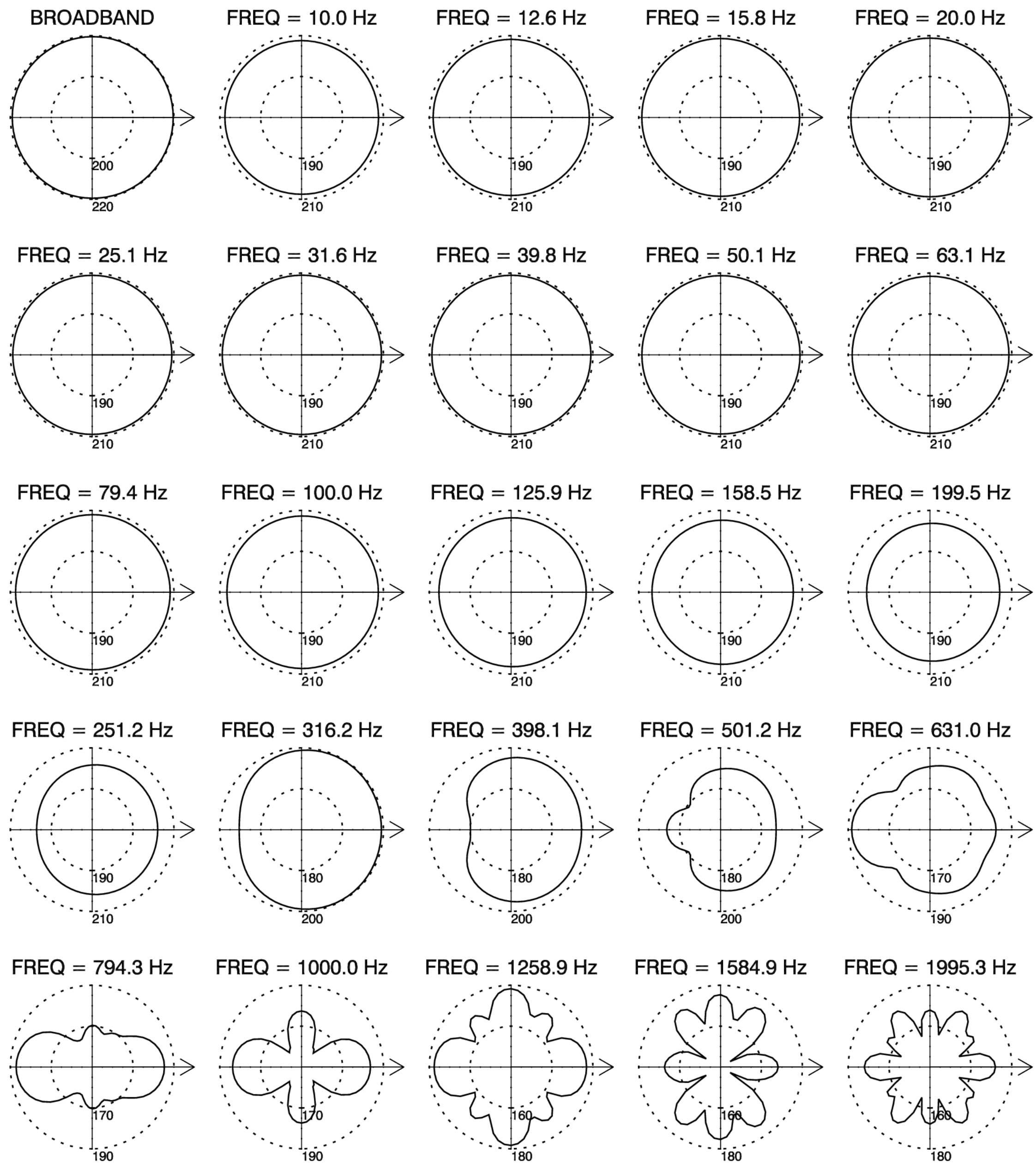

Figure 7. Azimuthal directivity patterns for the 760 in^3 ITAGA airgun array towed at 3-4 m depth in 1/3-octave bands, by center frequency. Units of the reference dashed circles are per-pulse SEL in μPa^{2}s.

3. Results

Broadband (10 Hz – 2 kHz) sound pressure level contours are mapped and threshold radii are listed for each modeled scenario in the following figures and tables. Received levels are rms SPL in units of dB re 1 μPa. The results are presented in all cases as the maximum SPL over depth, unless stated otherwise. Levels at any specific depth should be lower or equal to the indicated values.

3.1. Drill Rig Alone

Figure 8 presents the sound level isopleths for drilling operations at well site DP-5. Table 4 summarizes the 95th percentile radii to given threshold levels between 120 and 160 dB re 1 µPa, based on maxima over all depths and separately at 3 ft (1 m) above the seafloor that would be representative of measurements made on a seafloor-mounted recorder.

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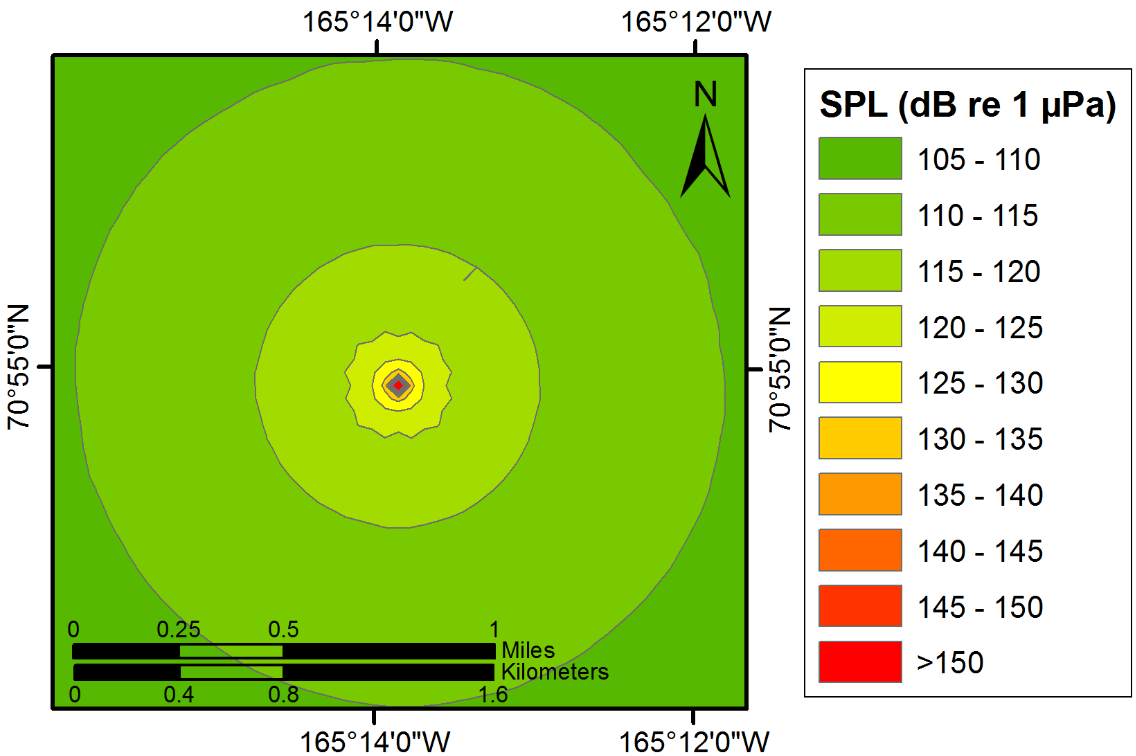

Figure 8. Maximum-over-depth sound level isopleths for drilling operations by drill rig only.

Table 4. Ninety-fifth percentile and maximum radii to significant threshold levels between 120 and 160 dB re 1 µPa for drilling operations by drill rig only.

SPL (dB re 1 µPa)	95th Percentile Radius (m)	Maximum Radius (m)
Maximum-over-depth		
160	<10	<10
150	<10	<10
140	<10	<10
130	50	50
120	210	210
Seafloor receiver		
160	<10	<10
150	<10	<10
140	<10	<10
130	50	50
120	180	180

3.2. Drill Rig with Ware Vessel

Figure 9 presents the sound level isopleths maps for drilling operations using the drill-rig at DP-5 and with the support vessel on dynamic positioning at the same location. Table 5 summarizes the 95th percentile radii to given threshold levels between 160 and 120 dB re 1 µPa in 10 dB steps, based on maxima over all depths and at a fixed depth at 3 ft (1 m) above the seafloor.

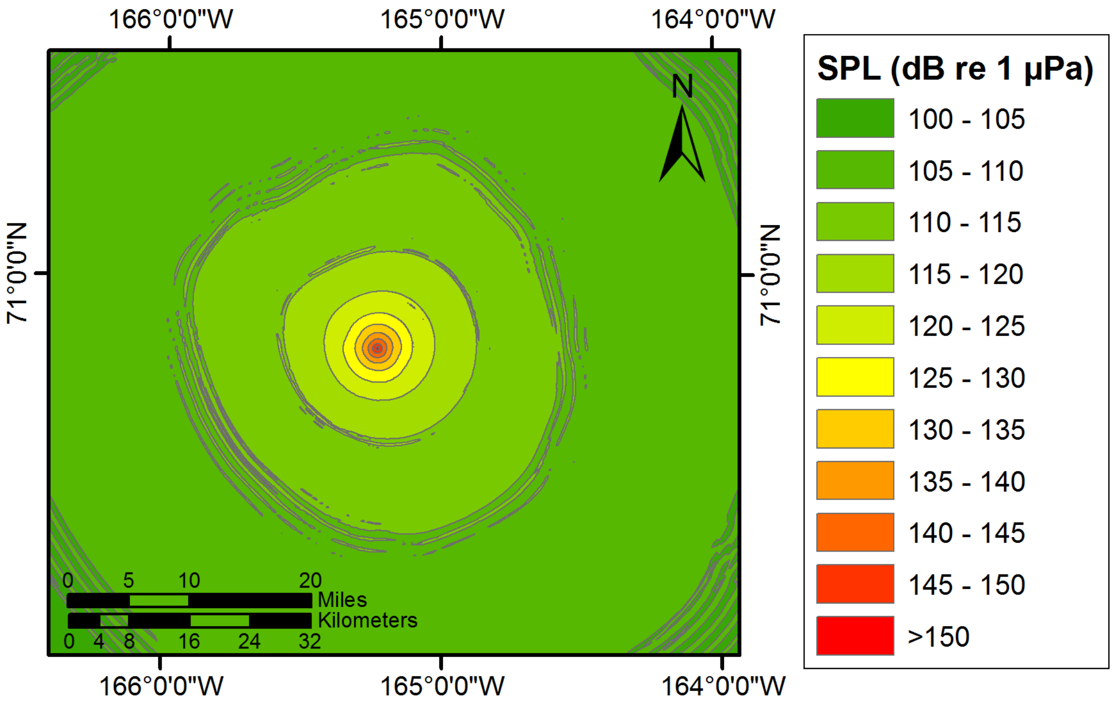

Figure 9. Maximum-over-depth sound level contours for drilling operations and support vessel on dynamic positioning.

Table 5. Ninety-fifth percentile and maximum radii to significant threshold levels between 120 and 160 dB re 1 µPa for drilling operations and support vessel on dynamic positioning.

SPL (dB re 1 µPa)	95th Percentile Radius (m)	Maximum Radius (m)
Maximum-over-depth		
160	71	71
150	250	260
140	1200	1300
130	3000	3200
120	7100	7900
Seafloor receiver		
160	71	71
150	220	250
140	1200	1300
130	2900	3100
120	5800	6300

3.3. 760 in^3 ITAGA Airgun Array

Figure 10 presents the sound level isopleths for the 760 in^3 ITAGA airgun array operating at drillsite DP-5. Table 6 presents threshold radii between 190 and 120 dB re 1 µPa in 10 dB steps for the maximum level over all depths as well as for a receiver at the sea floor. Distances marked with an asterisk are limited by the edge of the modeling area, and may underestimate the modeled radius; however, the conservative SEL to rms SPL conversion likely counteracts this effect.

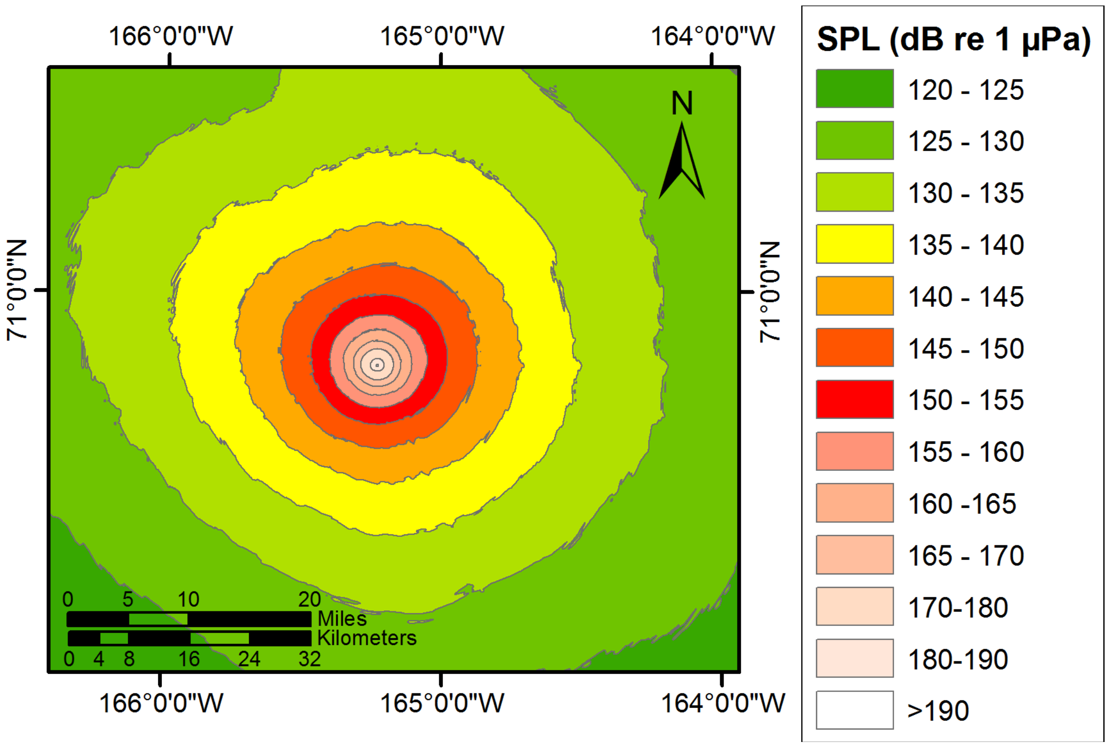

Figure 10. Maximum-over-depth sound level contours for the 760 in^3 ITAGA airgun array operating at drillsite DP-5.

Table 6. Ninety-fifth percentile and maximum radii to significant threshold levels between 120 and 190 dB re 1 µPa for the 760 in^3 ITAGA airgun array operating at drillsite DP-5.

SPL_{rms} (dB re 1 µPa)	95th Percentile Radius (m)	Maximum Radius (m)
Maximum-over-depth		
190	160	160
180	880	920
170	2100	2200
160	4500	4900
150	9000	9800
140	18000	20000
130	40000*	46000*
120	59000*	71000*
Seafloor receiver		
190	160	160
180	880	920
170	2100	2200
160	4400	4700
150	8100	8700
140	14000	16000
130	24000	27000
120	41000*	49000*

**contours extend beyond edge of modeling area, resulting in underestimation of radii.*

4. Summary

JASCO Applied Sciences' MONM modeling software was used to forecast the underwater acoustic levels resulting from the proposed drilling operations of a jack-up drill rig and support vessel adjacent to the rig on dynamic positioning. A separate model study was performed to estimate the sound footprint of a 760 in^3 ITAGA airgun array proposed for VSP data acquisition runs at the prospect well DP-5 at the Devils Paw Prospect in the Chukchi Sea. Sound isopleth maps and tables of ninety-fifth percentile and maximum threshold radii are presented. These radii were computed in two ways: first based on the maximum levels over depth, and second at a fixed depth of 1 m above the seafloor. The latter fixed-depth values should be representative of levels that would be measured on seafloor-deployed acoustic recorders. The maximum over depth radii are intended for conservative evaluation of potential effects of noise on marine mammals which could be present at any depth.

The noise footprint from operations using only the jack-up drill rig is small; the maximum distance to 120 dB re 1 µPa of the drill rig alone is estimated to be 210 m from the drillsite. The support vessel has substantially greater acoustic source level than the rig and its sound emissions dominate the combined drill rig and vessel noise field. Inclusion of the support vessel, holding dynamic position with thrusters beside the drill rig, increases the noise threshold radii. The maximum distance from the drillsite to 120 dB re 1 µPa for drill rig and support vessel is 7900 m. The distance to 160 dB re 1 µPa with drill rig and ware-vessel is 71 m. The estimated maximum distance to an rms SPL of 120 dB re 1 µPa for the ITAGA array was predicted to be >71000 m. This distance is comparable with measurements of the 120 dB re 1 µPa threshold radius from nearby surveys using larger airgun arrays, and this should consequently be considered conservative. The maximum 160 dB re 1 µPa threshold distance for the airgun array is predicted at 4900 m. Some uncertainties exist regarding appropriate vessel, drill rig and airgun source levels and/or operating scenarios. Where uncertainties in operating conditions exist the modelling has assumed conditions that generate the highest expected noise. Safety factors have been applied to source surrogates to account for possible mismatch with the actual sources. The final assumptions and safety factors applied are expected to lead to slightly conservative estimates of the true distances from the sources at which sound several level thresholds are reached. The specific assumptions and safety/uncertainty factors are discussed where applied.

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ATTACHMENT B

Marine Mammal Monitoring and Mitigation Plan for Offshore Exploration Drilling in the Devils Paw Prospect, Chukchi Sea, Alaska

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MARINE MAMMAL MONITORING AND MITIGATION PLAN FOR OFFSHORE EXPLORATION DRILLING IN THE DEVILS PAW PROSPECT, CHUKCHI SEA, ALASKA

February 28, 2012
October 15, 2012 (1st Revision)

Prepared by:

4311 Edinburgh Drive
Anchorage, AK 99502

Suite 2101, 4464 Markham Street
Victoria, BC, V8Z 7X8, Canada

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FIGURES

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ACRONYMS AND ABBREVIATIONS

4MP	Marine Mammal Monitoring and Mitigation Plan
BOEM	Bureau of Ocean Energy Management
CD	compact disc
Com-Station	Communication Station
COP	ConocoPhillips Company
dB	decibel
EPA	U.S. Environmental Protection Agency
ft	feet
GPS	Global Positioning System
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
Leq	equivalent continuous sound level
LOA	Letter of Authorization
m	meter(s)
mi	mile(s)
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
PSO	Protected Species Observer
re 1µPa	relative to 1 microPascal
rms	root mean square
USFWS	U.S. Fish and Wildlife Service
VSP	vertical seismic profile

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1. INTRODUCTION

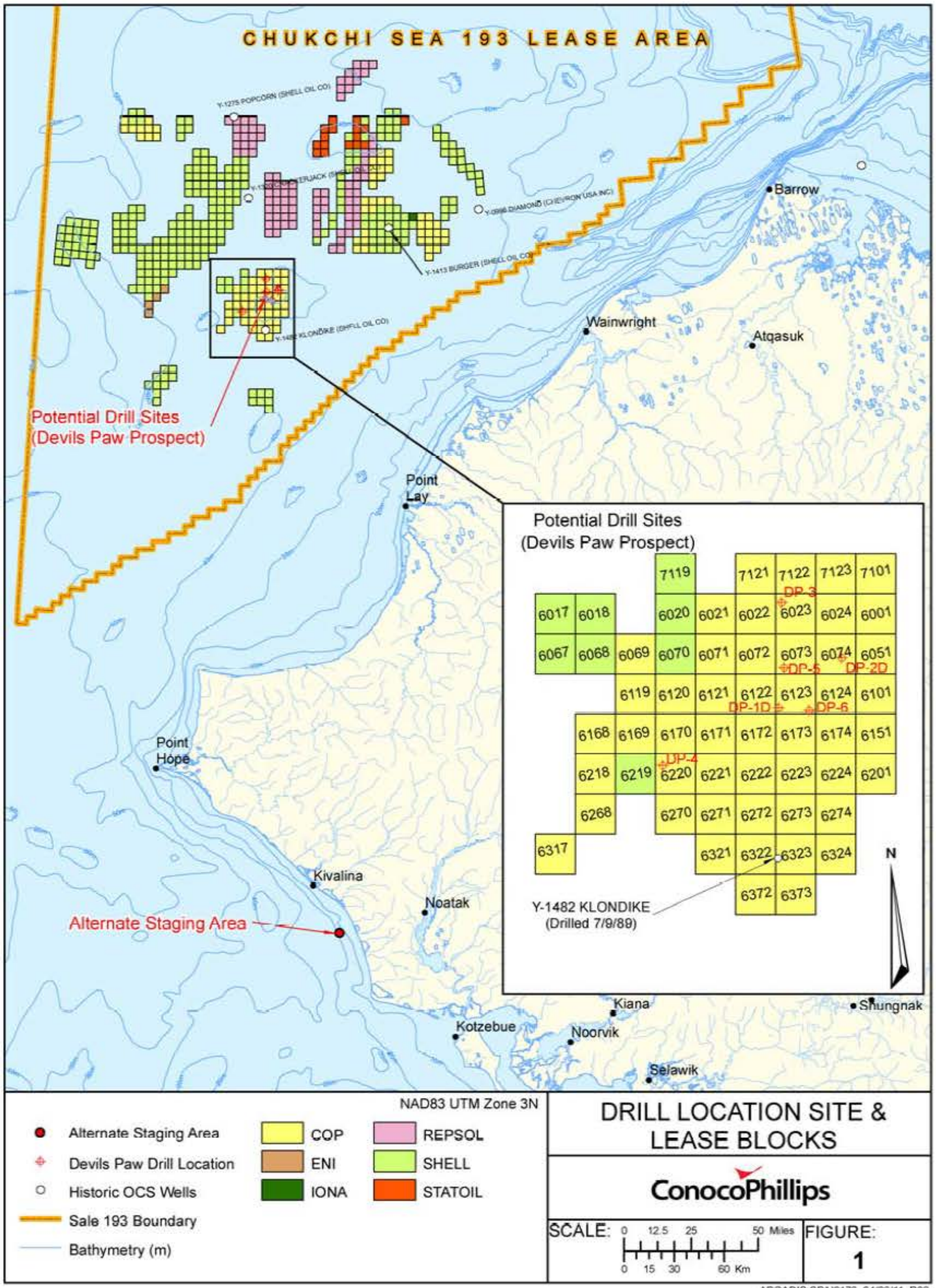
ConocoPhillips Company (COP) intends to drill one or two exploration wells within existing lease holdings in the Chukchi Sea during the open-water season of 2014 to test whether oil deposits are present in a commercially viable quantity and quality (Figure 1). The drilling will be conducted with a jack-up rig and a variety of vessels to support the drill rig operations. The support vessels will include tugs and barges, ice management and oil spill response vessels. A more detailed project plan and schedule is described in Section 1 of the Incidental Harassment Authorization (IHA) application to the National Marine Fisheries Service (NMFS) and the Letter of Authorization (LOA) application to U.S. Fish and Wildlife Service (USFWS).

A Marine Mammal Monitoring and Mitigation Plan (4MP) will be implemented during exploration drilling activities in the Chukchi Sea. The main purpose of the 4MP is to mitigate the potential impacts that project activities might have on marine mammals and the availability of subsistence resources, and to monitor the effectiveness of these measures. The 4MP and associated reporting are proposed to fulfill permit requirements of the Bureau of Ocean Energy Management (BOEM), the NMFS, and the USFWS. As such, the 4MP will be included as an Appendix to the IHA application to NMFS, the LOA application to USFWS, the ConocoPhillips Exploration Plan submitted to BOEM. The 4MP proposed by COP consists of monitoring specific to drilling activities, including rig- and vessel-based marine mammal monitoring and acoustic monitoring.

The main objective of marine mammal monitoring directly related to drilling activities is to minimize any potential impact on marine mammals and subsistence hunting in accordance with the Marine Mammal Protection Act (MMPA). Drilling activities-related monitoring consists of placing Protected Species Observers (PSOs) on the drill rig, on the ice management vessel, and the monitoring vessel. These observers will record all marine mammals sighted during daylight hours. Drilling activities-related monitoring also includes the use of acoustic recorders to characterize drilling sounds and sounds produced by adjacent vessel activities. On the monitoring vessel, the primary objective will be to monitor the discharge plumes, their chemical composition and potential effects on plankton and benthic communities. COP's *Monitoring Plan for Exploratory Drilling in the Chukchi Sea* contains discharge modeling results and proposed monitoring strategies; the current draft Plan may be modified to conform to monitoring requirements set out in the U.S. Environmental Protection Agency's (EPA) final National Pollutant Discharge Elimination System permit for the Chukchi Sea. The PSOs stationed on the monitoring vessel will record marine mammal sightings during the performance of monitoring during release of authorized discharges from the drill rig.

More information on the rig- and vessel-based marine mammal monitoring program and the acoustic monitoring is provided in sections 2 and 3 below. For clarification, future reference to vessel-based monitoring associated with this 4MP refers solely to the ice management vessel.

Figure 1 Map of COP's Devils Paw Prospect with Locations of Proposed Exploration Drilling Sites



Note: The primary candidate drilling site for 2014 is in Block 6073.
Source: COP, 2011

2. RIG-AND VESSEL-BASED MARINE MAMMAL MONITORING

The rig- and vessel-based marine mammal monitoring of COP's 4MP is designed in accordance with existing NMFS and USFWS guidelines. The main objectives of the marine mammal monitoring program are to:

- Minimize disturbance to marine mammals and subsistence hunts;
- Document potential effects on marine mammals from the proposed activities; and
- Collect data on the occurrence and distribution of marine mammals in the project area during exploration drilling.

Activities of the proposed drilling operations that could potentially harass marine mammals as defined under the MMPA[1] are drilling activities, dynamic positioned supply vessels, vertical seismic profiling (VSP), and ice management. The main source of impact is sounds generated by these activities, but the presence of an ice management vessel close to ice habitat could also potentially disturb marine mammals hauled out on ice. Sounds produced by vessels transiting to and from the drilling location are similar to that of conventional vessel traffic and are therefore not identified as an important source of potential impact.

Current NMFS guidelines (e.g. NMFS 2000) established sound criteria at which injury to marine mammals can occur at levels of 190 decibels (dB) relative to 1 microPascal (re 1 µPa) root mean square (rms) for pinnipeds and 180 dB re 1 µPa rms for cetaceans. NMFS uses a threshold of 120 dB re 1 µPa rms for all marine mammals under their jurisdiction for the onset of "level B harassment" (behavioral disturbance) from continuous non-pulsed sounds and 160 dB re 1µPa rms for behavioral disturbance from pulsed sounds (NMFS 2005, 2010). The IHA application to NMFS summarizes current knowledge of sound levels produced during jack-up drilling operations. It also presents the results of a modeling exercise estimating the distances at which relevant sound levels will occur during drilling alone, drilling combined with a support vessel on dynamic positioning alongside the rig and of operating airguns during the VSP data acquisition runs.

Based on the modeling information (O'Neill et al. 2011), the source levels associated with exploration drilling activities and vessel operations are not high enough to cause injury, such as a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. The VSP airgun sounds, however, may reach levels at which injury could occur. Two or three VSP data acquisition runs are planned from the jack-up rig per well, with a total of about two hours of actual airgun operations. If a second well is drilled in 2014, an additional two or three VSP data acquisition runs will be conducted for a combined total of up to 4 hours during the exploration drilling program. Consequently, mitigation as described for seismic activities including ramp up, power down, and shut down will be employed during the VSP data acquisition runs. Similar mitigation measures are not necessary for the other project activities due to their acoustic characteristics and inability to cause injury. The main goals of the PSOs onboard the drill rig and the ice management vessel are to monitor any presence of marine mammals and to record possible responses to industry activities. During their helicopter

[1] Under the MMPA, Level A harassment is defined as having the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, such as migration, nursing, breeding, feeding or sheltering.

transfers to and from the rig, PSOs will observe and record marine mammal sightings according to a standardized protocol.

2.1 Marine Mammal Observation Protocol

Experienced PSOs will be stationed on board the drill rig and ice-management vessel. The exact dates and operating areas will depend on ice and weather conditions, permit stipulations, and other stakeholder agreements.

The rig- and vessel-based marine mammal monitoring will serve the following objectives:

- Implement mitigation measures in the field, where necessary, as required by the various permits COP receives.
- Collect data on the occurrence, distribution, and activities of marine mammals in the areas where the drilling program is conducted.
- Collect information to compare the distances, distributions, behavior and movements of marine mammals relative to the drill rig at times with and without drilling activity.
- Collect information to estimate the number of marine mammals potentially harassed by the proposed project activities, which must be reported to NMFS and USFWS in accordance with the issued IHA and LOA.
- Communicate with coastal communities including Inupiat hunters.

At least four PSOs will be located on the drill rig to collect marine mammal data during drilling and resupply operations. These PSOs will also collect data and implement mitigation measures during the VSP data acquisition runs. COP believes that a continuous 24-hr monitoring effort is not required during drilling and resupply and presence of four PSOs on the rig will be sufficient to meet the monitoring objectives. Two PSOs will be present on the ice management vessel. This vessel will be utilized to investigate ice prior to arrival of the rig in the early season, if required. Once ice has moved away from the drilling site and any ice remaining near the site is identified, the ice management vessel will be on standby within about 5.5 miles (mi) (8.9 km) of the drill rig until needed to investigate ice floes that could potentially pose a risk to the drilling operations. The majority of vessel activity associated with the drilling operations will occur within view of the observers on the rig. For all vessel transits, COP will implement mitigation measures such as speed limits within proximity of marine mammals and communication to the Com-Station located at the village of Wainwright, as described in the IHA application under general mitigation measures and in the POC.

PSO teams will consist of trained Inupiat and biologist observers. The Inupiat observers will also function as communicators with hunters and whaling crews, and will report on a regular basis to the Communication Station (Com-Station). In addition to communicating with the Inupiat observers surrounding drilling activities, the Wainwright Com-Station will coordinate communication with marine vessels, and aircraft as appropriate, and serve as the primary point of contact for the communication outposts in each community as well as the subsistence hunters in Wainwright. The communication outposts will communicate the location of industry activities to subsistence hunting crews in the individual villages and inform the Com-Station in Wainwright of any hunting activity that may occur in the vicinity of operations. This system provides a mechanism that subsistence hunters can use to communicate their location(s) to industry operators operating in the Chukchi Sea, thus enhancing the potential for avoiding interference with subsistence harvest activities. Further details regarding the function of these communication systems are described in COP's Plan of Cooperation.

COP will provide or arrange for the following specialized field equipment for use by the PSOs: reticle binoculars, clinometers, big-eye binoculars (only on drill rig), global positioning system (GPS) receivers, laptop computers or other data recording devices, and digital still and video cameras.

2.1.1 Observer Qualifications and Training

All observers will have previous marine mammal observation experience, preferably in the Alaskan or Canadian Arctic. Resumes for the PSOs identified will be provided to NMFS.

Prior to their mobilization, all observers will receive training on drilling operations (e.g. overview of key activities), marine mammal monitoring protocol, data recording. A marine biologist with experience managing and executing marine mammal observer programs in the Arctic will provide this training. In addition, an Inupiat hunter will aid in the training by providing information on marine mammal identification and behaviors. An Observers' Handbook, adapted for the specifics of COP's proposed drilling program will be prepared and distributed to all PSOs as preparation for the training and as a reference document in the field. This Observer's Handbook will be made available to NMFS or other stakeholders if requested. Primary objectives of the training include:

- Review of the marine mammal monitoring plan for this project. This includes any requirements and stipulations specified by NMFS or USFWS in the IHA or LOA, respectively, by BOEM permit stipulations, or other agreements in which COP may elect to participate.
- Review of marine mammal sighting, identification, and distance estimation methods, including any amendments specified by NMFS or USFWS in the issued IHA or LOA.
- Familiarization with the use of all monitoring equipment available (e.g., reticle binoculars, big eye binoculars, clinometers and GPS).
- Review and classroom practice with data recording and data entry systems, including procedures for recording data on mammal sightings, drilling and monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers.

2.1.2 Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the drill rig and vessels. The observer(s) will scan systematically with the naked eye and 7×50 reticle binoculars, supplemented with big-eye binoculars (on the drill rig). Personnel on the bridge will assist the PSO(s) in watching for pinnipeds and cetaceans. When a mammal sighting is made, the following information about the sighting will be recorded:

- Species, group size, number of juveniles (where possible), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from observer, apparent reaction to activities, pace.
- Time, location, vessel speed and activity (where applicable), sea state, ice cover, visibility and sun glare.

- The positions of other vessel(s) in the vicinity of the observer location or the position and distance of the jack-up rig from the vessel, where applicable.
- The ship's position and speed (for PSO on vessels) or the drill rig activity (i.e., drilling or not; for PSOs on the drill rig), water depth, sea state, ice cover, visibility and sun glare during the watch.

Distances to nearby marine mammals will be estimated by eye or with binoculars containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that a Class 1 eye-safe device was not able to measure distances to seals more than about 230 feet (ft) (70 meters [m]). The device was very useful in improving the distance estimation abilities of the observers at distances up to about 1,968 ft (600 m)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20 percent when given immediate feedback about actual distances during training.

2.1.3 Data-Recording, Verification and Handling

The observers on the drill rig and ice management vessel will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the data. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session; (2) subsequent supervision by the onboard field crew leader; and (3) ongoing data checks during the field season. Observations will be reported to NMFS on a daily basis, including a graphical display of the sighting locations. However, due to the quick turnaround required for these daily data submittals, the sightings will be labeled as "DRAFT" pending final quality control checks of those data throughout and at end of the field season.

The data will be backed up regularly onto compact discs (CDs) and/or portable universal serial bus devices, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

In addition to routine PSO duties, observers will be encouraged to record comments about their observations into the "comment" field in the database. Copies of these records will be available to the observers for reference if they wish to prepare a statement about their observations.

2.2 Implementation of Mitigation Measures

COP's planned exploration drilling program will incorporate operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The pre-season modeling of acoustic footprints of various drilling-related activities was conducted to guide mitigation at the design and planning stage. Based on current knowledge, the drilling activities, including movements of support vessels, will not lead to injury of marine mammals, such as a temporary reduction in hearing sensitivity or permanent hearing damage. Monitoring of safety zones is therefore not applicable. The distance at which received sound levels occur that have the potential for behavioral disturbance, are approximately 787 ft (240 m) for drilling only and approximately 12,919 ft (7,900 m) for drilling with support vessel activity. Observers at the drill rig will monitor this zone, documenting presences and behavior of marine mammals during these activities. The rig and vessel operators will adhere to the general mitigation measures outlined in the IHA application, as applicable.

During the planned VSP tests, received sound levels can increase to levels that have the potential to cause auditory injury to marine mammals in close proximity. The distance to received levels of 190 dB and 180 dB re 1µPa rms during these activities are estimated to be 160 m and 920 m, respectively (O' Neill et al. 2011). This means that during VSP tests from the jack-up rig, specific mitigation procedures will be implemented in addition to the general mitigation measures. Proposed general and specific mitigation measures are described in the IHA application.

2.3 Field Reports

Throughout the drilling program, the PSOs based on the drill rig and ice management vessel will prepare marine mammal reports on an as needed basis. These reports will summarize information on marine mammals sighted and mitigation measures that were implemented, as applicable. These reports will be made available to relevant stakeholders (e.g., NMFS/National Marine Mammal Laboratory, USFWS, AEWC, NSB, BOEM). During community visits, COP will solicit input regarding additional interest in the receipt of field reports.

3. ACOUSTIC MONITORING

Sound levels from drilling activities and vessels are expected to vary significantly with time due to variations in the operations and the different types of equipment used at different times onboard the drill rig. The goals of the project-specific acoustic monitoring program are to (1) quantify the absolute sound levels produced by drilling and to monitor their variations with time, distance and direction from the drill rig; (2) measure the sound levels produced by vessels operating in support of drilling operations; (3) measure sounds from VSP data acquisition runs; and (4) detect vocalization of marine mammals.

To accomplish these goals, implementation of autonomous monitoring using bottom-founded acoustic recorders is proposed during exploration drilling.

3.1 Autonomous Monitoring with Bottom-Founded Acoustic Recorders

Monitoring of sound levels from drilling and vessel activities will occur on a continuous basis throughout the entire drilling season with a set of bottom-founded acoustic recorders. These recorders are also able to characterize sound levels generated by airguns during the VSP tests. At least four recorders will be deployed on the seafloor at distances of approximately 0.31 mi (0.5 kilometer [km], 0.62 mi (1 km), 2.5 mi (4 km), and 6.2 mi (10 km) from the drill rig. The bottom-founded recorders will be set to record at a sample rate of 16 or 32 kilohertz (kHz), providing useful acoustic bandwidth to 8 or 16 kHz. Calibrated reference hydrophones will be used for the measurements, capable of measuring absolute broadband sound levels between 90 and 200 dB re µPa rms. The deployment of the bottom-founded acoustic monitoring equipment will occur just prior to placement of the drill rig at the location(s) where COP intends to drill an exploration well. After the first VSP data acquisition run, the recorders will be retrieved and the data downloaded. Recorders will then be deployed again, and will remain in place until completion of all drilling activities. The three main objectives of the bottom-founded autonomous hydrophones are:

- Provide long duration recordings capturing sound levels of all operations performed at the drill rig and of all vessel movements in the vicinity through post-season analyses.
- Calculate source levels, and distances to sound levels of 160 dB and 120 dB re 1µPa rms from drilling activities and vessels supporting the drill rig and distances to 160 dB from VSP airgun sounds.
- Record marine mammal vocalizations during the drilling season to be compared with visual observations during post-season analyses.

If feasible, vessels for which source levels have not been measured before, will run a predetermined transect over the bottom-founded autonomous acoustic recorder locations. These dedicated measurements will provide sound level versus distance from the respective vessels and will also be processed to compute source levels in 1/3-octave bands referenced to a 1 m range. Similar post-season statistics will also be calculated for sounds generated by the drill rig and the VSP airgun sounds

3.2 Acoustic Data Analyses

Post-season analyses of the autonomous system will provide a record of frequency-dependent sound levels of drilling activities as a function of time. Accurate activity logs of drilling operations will be needed to correlate measured sound energy events with specific drilling operations.

Detailed logs of vessel position and activity will be required and used to determine the time varying contribution of each vessel to the overall sound level footprint.

The analyses will provide absolute sound levels in finite frequency bands that can be tailored to match the highest-sensitivity hearing ranges for species of interest, e.g., bowhead whales. The analyses will also consider sound level averaged over 1-hour periods, referred to as equivalent continuous sound level (Leq) [Leq 1-hour]. Similar graphs will be generated to indicate drilling sound variation with time for long time periods in selected frequency bands.

4. REPORTING

Marine mammal monitoring results and acoustic sound levels specific to the drilling operations (including vessels) and VSP profiling will be reported to the NMFS and USFWS as per stipulations in the IHA and LOA issued.

Reporting of marine mammal monitoring results will include the following information.

- Summary of monitoring effort: total hours of effort (for rig-based observations or observations from the ice management vessel when stationary) and total kilometer of effort (for non-stationary vessel-based observations)
- Effective area of observation, and distribution of marine mammals through study period.
- Analyses of the effects of various factors influencing detectability of marine mammals: sea state, number of observers and fog/glare.
- Species composition, occurrence, and distribution of marine mammal sightings including date, numbers, juveniles or adults, group sizes and ice cover.
- Analyses of the effects of drilling operations. The potential to successfully achieve the objectives listed here is subject to the number of animals observed during the survey period. Where possible we will use data collected during the 2008-2012 CSESP studies to better evaluate potential effects of the activities (for example by using the estimated *f(0)* values from these data).
  - Numbers of sightings/individuals observed and sighting rates of marine mammals versus drilling activities (and other variables that could affect detectability).
  - Distribution around the drill rig and support vessels versus drilling state.
  - Initial sighting distances and closest point of approach versus drilling state.
  - Observed behaviors and types of movements versus drilling state.
  - Estimates of “take by harassment”, including estimates of uncertainty.
- COP will attempt to use visualization methods to present the data in a format that facilitates the understanding of the project activities and monitoring results.

Reporting of acoustic monitoring results will include the following information.

- Sound source levels of drilling activities from the jack-up rig, of support vessels, and of the VSP airguns.
- Spectrogram and band level versus time plots computed from the continuous recordings obtained from selected hydrophone systems.
- Hourly Leq levels at the hydrophone locations in graphic format.
- Correlation of drilling source levels with type of drilling operations performed. These results will be obtained by observing differences in drilling sound associated with differences in the drill rig activity as indicated in detailed drill logs.
- Temporal and spatial presence of marine mammals based on acoustic detections of vocalizations.

5. LITERATURE CITED

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