Final Environmental Assessment
For the Issuance of an Incidental Harassment Authorization for the Take of Marine Mammals by Harassment Incidental to Conducting an Exploration Drilling Program in the U.S. Chukchi Sea

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LOCATION:	U.S. Chukchi Sea

ABSTRACT: National Marine Fisheries Service proposes to issue an Incidental Harassment Authorization (IHA) to Shell Offshore Inc. and Shell Gulf of Mexico Inc. (collectively “Shell”) for the take of marine mammals incidental to conducting an exploration drilling program in the U.S. Chukchi Sea.

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Table of Contents

List of Acronyms, Abbreviations, and Initialisms

2D	2-dimensional
3D	3-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
ABWC	Alaska Beluga Whale Committee
ACIA	Arctic Climate Impact Assessment
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AHD	Acoustic Harassment Device
ANO	Alaska Native Organization
BACT	Best Available Control Technology
bbl	barrels
BCB	Bering-Chukchi-Beaufort Seas (stock of bowhead whale)
BLM	Bureau of Land Management
BOD	Biochemical Oxygen Demand
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Mangement, Regulation and Enforcement
BOP	Blowout Preventer
BP	BP Exploration Alaska
BSEE	Bureau of Safety and Environmental Enforcement
C	Celsius
CDFO	Canadian Department of Fisheries & Oceans
CFR	Code of Federal Regulations
CEQ	President’s Council on Environmental Quality
cm	centimeter
cm^3	cubic centimeter
COMIDA	Chukchi Offshore Monitoring in Drilling Area
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DASAR	Directional Autonomous Seafloor Acoustic Recorder
dB	decibel
DOI	Department of the Interior
DPS	Distinct Population Segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EVOS	Exxon Valdez Oil Spill
FM	frequency-modulated
FMP	Fishery Management Plan
ft	foot/feet
FR	Federal Register
hr	hour

Hz	hertz
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
IMP	Ice Management Plan
in^3	cubic inch
ION	ION Geophysical
IPCC	Intergovernmental Panel on Climate Change
IWC	International Whaling Commission
kHz	kilohertz
kg	kilogram
km	kilometer
km^2	square kilometer
L-DEO	Lamont-Doherty Earth Observatory
LME	Large Marine Ecosystem
m	meter
m^2	square meter
m^3	cubic meter
mi	mile
mi^2	square mile
MLC	Mudline Cellar
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAAQS	National Ambient Air Quality Standards
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NRC	National Research Council
NSB	North Slope Borough
NSIDC	National Snow and Ice Data Center
NSR	New Source Review
OCS	Outer Continental Shelf
OMB	Office of Management and Budget
OSR	Oil Spill Response
OST	Oil Spill Tanker
p-p	peak-to-peak
PAH	Polycyclic Aromatic Hydrocarbons
POC	Plan of Cooperation
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
PSO	Protected Species Observer
psu	practical salinity units
PTS	Permanent Threshold Shift
rms	root-mean-square

s	second
SAR	Search and Rescue
SEL	Sound Exposure Level
SIWAC	Shell Ice and Weather Advisory Center
SPL	Sound Pressure Level
TS	Threshold Shift
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial Surveys
U.S.C.	United States Code
USCG	United States Coast Guard
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
VSI	Vertical Seismic Imager
yr	year
ZVSP	Zero-offset Vertical Seismic Profile
μPa	micro pascal

Chapter 1 INTRODUCTION AND PURPOSE AND NEED

1.1 Description of Proposed Action

The Marine Mammal Protection Act (MMPA) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under three categories: mortality, serious injury, or harassment, which includes injury and behavioral effects. The MMPA defines harassment as any act of pursuit, torment, or annoyance which: (1) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). There are exceptions to the MMPA's prohibition on take, such as the authority at issue here for us to authorize the incidental taking of small numbers of marine mammals by harassment upon the request of a U.S. citizen provided we follow certain statutory and regulatory procedures and make determinations. This exception is discussed in more detail in Section 1.2.

We propose to issue an Incidental Harassment Authorization (IHA) to the Shell Offshore Inc. and Shell Gulf of Mexico Inc. (collectively "Shell") under the MMPA for the taking of small numbers of marine mammals, incidental to Shell's exploration drilling program in the U.S. Chukchi Sea during the 2015 Arctic open-water season. We do not have the authority to permit, authorize, or prohibit Shell's drilling activities.

Our proposed action is a direct outcome of Shell requesting an IHA under Section 101(a)(5)(D) of the MMPA to take marine mammals, by harassment, incidental to conducting the exploration drilling program. Underwater noises associated with the drilling activities and ice management / icebreaking have the potential to take, by harassment, marine mammals. Shell therefore requires an IHA for incidental take.

Our issuance of an IHA to Shell is a major federal action under the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations in 40 CFR §§ 1500-1508, and NOAA Administrative Order (NAO) 216-6. Thus, we are required to analyze the effects of our proposed action.

This Final Environmental Assessment, titled "*Issuance of an Incidental Harassment Authorization for the Take of Marine Mammals by Harassment Incidental to Conducting an Exploration Drilling Program in the U.S. Chukchi Sea*," (hereinafter, EA) addresses the potential environmental impacts of four alternatives, namely:

- Issue the Authorization to Shell under the MMPA for Level B harassment of marine mammals during Shell's exploration drilling program at two drilling sites, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorization; or

- Issue the Authorization to Shell under the MMPA that would only be valid for a much shorter time for Level B harassment of marine mammals during Shell's exploration drilling program, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorization; or

- Issue the Authorization to Shell under the MMPA that would only allow for Level B harassment of marine mammals during Shell's exploration drilling program at one drill site, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorization; or

- Not issue an Authorization to Shell, in which casewe assume that Shell would not proceed with its drilling activities and would not cause incidental take.

1.1.1 Background on Shell's MMPA Application

On September 18, 2014, Shell submitted an application to NMFS for the taking of marine mammals incidental to exploration drilling activities in the Chukchi Sea, Alaska. After receiving NMFS comments and questions from NMFS, Shell made revision and updated its IHA application and the revised Marine Mammal Mitigation and Monitoring Plan (4MP) on December 17, 2014. NMFS determined that the application was adequate and complete on January 5, 2015.

The proposed activity would occur between July and October 2015. The following specific aspects of the proposed activities are likely to result in the take of marine mammals: exploration drilling, supply and drilling support vessels using dynamic positioning, mudline cellar construction, anchor handling, ice management activities, and zero-offset vertical seismic profiling (ZVSP) activities.

1.1.2 Marine Mammals in the Action Area

Shell has requested an authorization to take 13 marine mammal species by Level B harassment. However, the narwhal (*Monodon monoceros*) is not expected to be found in the activity area. Therefore, NMFS is proposing to authorize take of 12 marine mammal species, by Level B harassment, incidental to Shell's offshore exploration drilling in the Chukchi Sea. These species include: beluga whale (*Delphinapterus leucas*); bowhead whale (*Balaena mysticetus*); gray whale (*Eschrichtius robustus*); killer whale (*Orcinus orca*); minke whale (*Balaenoptera acutorostrata*); fin whale (*Balaenoptera physalus*); humpback whale (*Megaptera novaeangliae*); harbor porpoise (*Phocoena phocoena*); bearded seal (*Erignathus barbatus*); ringed seal (*Phoca hispida*); spotted seal (*P. largha*); and ribbon seal (*Histriophoca fasciata*).

1.2 Purpose and Need

The MMPA prohibits "takes" of marine mammals, with a number of specific exceptions. The applicable exception in this case is an authorization for incidental take of marine mammals in section 101(a)(5)(D) of the MMPA.

Section 101(a)(5)(D) of the MMPA directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if we make certain findings and provide a notice of a proposed authorization to the public for review. Entities seeking to obtain authorization for the incidental take of marine mammals under our jurisdiction must submit such a request (in the form of an application) to us.

We have issued regulations to implement the Incidental Take Authorization provisions of the MMPA (50 CFR Part 216) and have produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for authorizations. All applicants must comply with the regulations at 50 CFR § 216.104 and submit applications requesting incidental take according to the provisions of the MMPA.

Purpose: The primary purpose of our proposed action—the issuance of an Authorization to Shell—is to authorize (pursuant to the MMPA) the take of marine mammals incidental to Shell's proposed activities. The IHA, if issued, would exempt Shell from the take prohibitions contained in the MMPA.

To authorize the take of small numbers of marine mammals in accordance with Section 101(a)(5)(D) of the MMPA, we must evaluate the best available scientific information to determine whether the take would have a negligible impact on the affected marine mammals species or stocks and not have an unmitigable adverse impact on the availability of affected marine mammal species for certain subsistence uses. We cannot issue an IHA if it would result in more than a negligible impact on marine mammal species or stocks or if it would result in an unmitigable adverse impact on subsistence.

In addition, we must prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat (i.e., mitigation), paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. Authorizations must also include requirements or conditions pertaining to the monitoring and reporting of such taking, in large part to better understand the effects of such taking on the species. Also, we must publish a notice of a proposed Authorization in the *Federal Register* for public notice and comment.

The underlying purpose of this action is therefore to determine whether the take resulting from Shell's exploration drilling program in the Chukchi Sea during the 2015 Arctic open-water season would have a negligible impact on affected marine mammal species or stocks and would not have an unmitigable adverse impact on the availability of marine mammals for taking for subsistence uses, and to develop mitigation and monitoring measures to reduce the potential impacts.

Need: On December 17, 2014, Shell submitted an adequate and complete application demonstrating both the need and potential eligibility for issuance of an IHA in connection with the activities described in section 1.1.1. We now have a corresponding duty to determine whether and how we can authorize take by Level B harassment incidental to the activities described in Shell's application. Our responsibilities under section 101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for this proposed action.

Any alternatives considered under NEPA must meet the agency's statutory and regulatory requirements. Our described purpose and need guide us in developing reasonable alternatives for consideration, including alternative means of mitigating potential adverse effects. Thus, we are developing and analyzing alternative means of developing and issuing an Authorization, which may require the applicant to include additional mitigation and monitoring measures in order for us to make our determinations under the MMPA.

1.3 Environmental Review Process

NEPA compliance is necessary for all "major" federal actions with the potential to significantly affect the quality of the human environment. Major federal actions include activities fully or partially funded, regulated, conducted, authorized, or approved by a federal agency. Because our issuance of an Authorization would allow for the taking of marine mammals consistent with provisions under the MMPA and incidental to the applicant's activities, we consider this as a major federal action subject to NEPA.

Under the requirements of NAO 216-6 section 6.03(f)(2)(b) for incidental harassment authorizations, we prepared this EA to determine whether the direct, indirect and cumulative impacts related to the issuance of an IHA for incidental take of marine mammals during the conduct of Shell's exploration drilling program in the Chukchi Sea, could be significant. If we deem the potential impacts to be not significant, this analysis, including other analyses incorporated by reference, may support the issuance of a Finding of No Significant Impact (FONSI) for the proposed Authorization.

1.3.1 Laws, Regulations, or Other NEPA Analyses Influencing the EA's Scope

We have based the scope of the proposed action and nature of the four alternatives considered in this EA on the relevant requirements in section 101(a)(5)(D) of the MMPA. Thus, our authority under the MMPA bounds the scope of our alternatives. We conclude that this analysis—when combined with the analyses in the following documents—fully describes the impacts associated with the proposed construction project with mitigation and monitoring for marine mammals. After conducting a review of the information and analyses for sufficiency and adequacy, we incorporate by reference the relevant analyses on Shell's proposed action as well as discussions of the affected environment and environmental consequences within the following documents, per 40 CFR §1502.21 and NAO 216-6 § 5.09(d):

- *Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with Planned Exploration Drilling Activities During 2015 Chukchi Sea, Alaska* (Shell, 2014a),
- *Environmental Impact Analysis, Revision 2, Exploration Plan, Chukchi Sea, Alaska Burger Prospect: Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915Chukchi Sea Lease Sale 193*. (Shell, 2014b), and

- *Revised Outer Continental Shelf Lease Exploration Plan, Chukchi Sea, Alaska*. (Shell, 2014c).
- *Draft Revised Outer Continental Shelf Lease Exploration Plan, Chukchi Sea, Alaska***.** (BOEM 2014).
- *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Final Second Supplemental Environmental Impact Statement.* (BOEM 2015).

MMPA APPLICATION AND NOTICE OF THE PROPOSED AUTHORIZATION
The CEQ regulations (40 CFR § 1502.25) encourage federal agencies to integrate NEPA's environmental review process with other environmental reviews. We rely substantially on the public process for developing proposed Authorizations and evaluating relevant environmental information and provide a meaningful opportunity for public participation as we develop corresponding EAs. We fully consider public comments received in response to our publication of the notice of proposed Authorization during the corresponding NEPA process.

We prepared a *Federal Register* notice (80 FR 11726; March 4, 2015) on the proposed activity and request that the public submit comments, information, and suggestions concerning Shell's request, the content of our proposed IHA, and potential environmental effects related to the proposed issuance of the Authorization.

1.3.2 Scope of Environmental Analysis

Given the limited scope of the decision for which we are responsible (*i.e.*, issue the IHA including prescribed means of take, mitigation measures, and monitoring requirements, or not issue the IHA), this EA provides more focused information on the primary issues and impacts of environmental concern related specifically to our issuance of the IHA. This EA does not further evaluate effects to the elements of the human environment listed in Table 1, because other environmental reviews (BOEM 2014; 2015) have shown that the issuance of an IHA for activities similar to Shell's proposed exploration drilling program would not significantly affect those components of the human environment. Moreover, those analyses are consistent with our MMPA analysis.

Table 1. Components of the human environment not affected by our issuance of an IHA.

Biological	Physical	Socioeconomic / Cultural
Lower trophic organisms	Air Quality	Commercial Fishing
Fish	Essential Fish Habitat	Military Activities
Mammal species not under NMFS jurisdiction	Geography	Recreational Fishing
Seabirds	Oceanography	Shipping and Boating
		National Historic Preservation Sites

		Low Income Populations
		Minority Populations
		Indigenous Cultural Resources
		Public Health and Safety
		Historic and Cultural Resources

1.3.3 Comments on This EA

NAO 216-6 established NOAA procedures for complying with NEPA and the implementing NEPA regulations issued by the CEQ. Consistent with the intent of NEPA and the direction in NAO 216-6 to involve the public in NEPA decision-making, we prepared a draft EA, along with a *Federal Register* Notice (80 FR 11726; March 4, 2015) for the proposed IHA for public comment on the potential environmental impacts of our issuance of an IHA.

During the 30-day public comment period, NMFS received omments from the Marine Mammal Commission; the Alaska Eskimo Whaling Commission; the North Slope Borough; Shell; the Northern Alaska Environment Center; the Environmental Investigation Agency; Oceana, Ocean Conservancy, and Audubon Alaska; and Alaska Wilderness League, Center for Biological Diversity, Earthjustice, EIA, Greenpeace, Natural Resources Defense Council, NAEC, Ocean Conservation Research, and Sierra Club, along with a form letter signed by 180,036 private citizens (with many duplicate submissions). All comments will be addressed in the *Federal Register* notice announcing our final decision on the proposed issuance of the IHA.

The comments primarily focused on: (1) requirements under the MMPA, NEPA and ESA; (2) impacts of noise and potential oil spills on marine mammals and the subsistence lifestyle of impacted communities; and (3) the mitigation and monitoring measures proposed by Shell and NMFS. In reviewing these concerns (which are addressed in NMFS' final IHA determination and the Final EA), NMFS determined that its action is in compliance with NEPA, the MMPA, the ESA and other statutes.

1.4 Other Permits, Licenses, or Consultation Requirements

This section summarizes federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action.

1.4.1 Marine Mammal Protection Act

The MMPA and its provisions that pertain to the proposed action are discussed above in section 1.2.

1.4.2 Endangered Species Act

The bowhead, humpback, and fin whales and ringed seal are the only marine mammal species currently listed under the ESA that could occur in the vicinity of Shell's proposed exploration drilling program. NMFS' Permits and Conservation Division has initiated consultation with NMFS' Alaska Regional Protected Resources Division under section 7 of the ESA on the issuance of an IHA to Shell under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of an IHA.

In June 2015, NMFS finished conducting its section 7 consultation and issued a Biological Opinion, and concluded that the issuance of the IHA associated with Shell's 2015 Chukchi Sea drilling program is not likely to jeopardize the continued existence of the endangered bowhead, humpback, and fin whale, and the Arctic sub-species of ringed seal. No critical habitat has been designated for these species, therefore none will be affected.

1.4.3 Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency which may adversely affect essential fish habitat (EFH) identified under the MSFCMA. These proposed IHAs, while necessary for the conservation and management of marine life, do not affect policies relevant to the National Standards of the MSFCMA. NMFS' Office of Protected Resources Permits and Conservation Division has determined that the issuance of IHAs for the taking of marine mammals incidental to conducting an offshore exploration drilling program in the U.S. Chukchi Seas will not have an adverse impact on EFH; therefore, an EFH consultation is not required.

1.4.4 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) encourages coastal states to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. The CZMA emphasizes the primacy of state decision-making regarding the coastal zone. Section 307 of the CZMA (16 U.S.C. § 1456), called the Federal consistency provision, is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's Federally-approved coastal management program. On July 1, 2011, the Federally-approved Alaska Coastal Management Program expired, resulting in a withdrawal from participation in CZMA's National Coastal Management Program. The Federal CZMA consistency provision in Section 307 no longer applies in Alaska.

Chapter 2 ALTERNATIVES

2.1 Introduction

NEPA and the CEQ implementing regulations (40 CFR §§ 1500-1508) require consideration of alternatives to proposed major federal actions and NAO 216-6 provides NOAA policy and guidance on the consideration of alternatives to our proposed action. An EA must consider all reasonable alternatives, including the Preferred Alternative. It must also consider the No Action Alternative, even if it that alternative does not meet the stated purpose and need. This provides a baseline analysis against which we can compare the other alternatives.

To warrant detailed evaluation as a reasonable alternative, an alternative must meet our purpose and need. In this case, as we previously explained in Chapter 1 of this EA, an alternative only meets the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. We evaluated each potential alternative against these criteria; identified one action alternative along with the No Action Alternative; and carried these forward for evaluation in this EA. This chapter describes the alternatives and compares them in terms of their environmental impacts and their achievement of objectives.

As described in Section 1.2, the MMPA requires that we must prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat and have no unmitigable impact on subsistence use of marine mammals. In order to do so, we must consider Shell's proposed mitigation measures, as well as other potential measures, and assess how such measures could minimize impacts on the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death, wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically

important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and

- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

2.2 Description of Shell's Proposed Activities

Shell proposes to conduct exploration drilling at up to four of six exploration drill sites on the OCS leases acquired from the U.S. Department of Interior, Bureau of Ocean Energy Management (BOEM). The exploration drilling planned for the 2015 season is a continuation of the Chukchi Sea exploration drilling program that began in 2012, and resulted in the completion of a partial well at the location known as Burger A. Exploration drilling will be done pursuant to Shell's Chukchi Sea Exploration Plan, Revision 2 (EP).

Shell plans to use two drilling units, the drillship *Noble Discoverer* (*Discoverer*) and semi-submersible *Transocean Polar Pioneer* (*Polar Pioneer*) to drill at up to four locations on the Burger Prospect. Both drilling units will be attended to by support vessels for the purposes of ice management, anchor handling, oil spill response (OSR), refueling, support to drilling units, and resupply. The drilling units will be accompanied by an expanded number of support vessels, aircraft, and oil spill response vessels (OSRV) greater than the number deployed during the 2012 drilling season.

2.2.1 Dates and Duration

Shell anticipates that its exploration drilling program will occur between July 1 and November 2015. The drilling units will move through the Bering Strait and into the Chukchi Sea on or after July 1, 2015, and then onto the Burger Prospect as soon as ice and weather conditions allow. Exploration drilling activities will continue until on or about October 31, 2015, the drilling units and support vessels will exit the Chukchi Sea at the conclusion of each exploration drilling season. Transit entirely out of the Chukchi Sea by all vessels associated with exploration drilling may take well into the month of November due to ice, weather, and sea states.

2.2.2 Specific Geographic Region

All drill sites at which exploration drilling would occur in 2015 will be at Shell's Burger Prospect as described in the Revised Chukchi Sea EP submitted to BOEM (Figure 1). Shell has identified a total of six Chukchi Sea lease blocks on the Burger Prospect. All six drill sites are located more than 64 mi (103 km) off the Chukchi Sea coast. During 2015, the Discoverer and Polar Pioneer will be used to conduct exploration drilling activities at up to four exploration drill sites. As with any Arctic exploration program, weather and ice conditions will dictate actual operations.

Activities associated with the Chukchi Sea exploration drilling program and analyzed herein include operation of the *Discoverer*, *Polar Pioneer*, and associated support vessels. The drilling units will remain at the location of the designated exploration drill sites except when mobilizing and demobilizing to and from the Chukchi Sea, transiting between drill sites, and temporarily moving off location if it is determined ice conditions require such a move to ensure the safety of personnel and/or the environment.

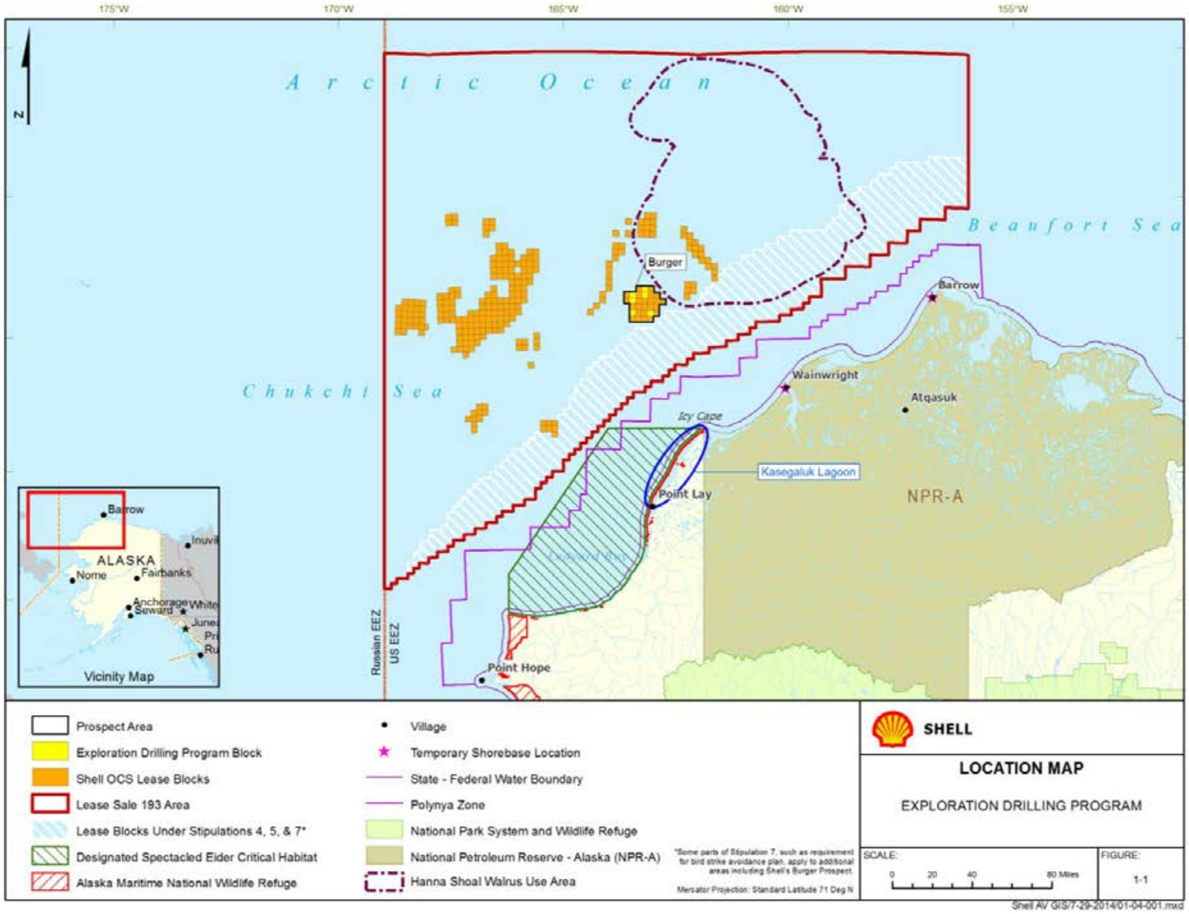

Figure 1. Exploration Drilling Program Location Map

2.2.3 Detailed Description of Activities

The specific activities that may result in incidental taking of marine mammals pursuant to the requested IHA are limited to Shell's exploration drilling program and related activities. Activities include exploration drilling sounds, mudline cellar (MLC) construction, anchor handling while mooring a drilling unit at a drill site, vessels on DP when tending to a drilling unit, ice management, and ZVSP surveys.

(1) Exploration Drilling

In 2015 Shell plans to continue its exploration drilling program on BOEM Alaska OCS leases at drill sites greater than 64 mi (103 km) from the Chukchi Sea coast during the 2015 drilling season. Shell plans to conduct exploration drilling activities at up to four drill sites at the Burger Prospect utilizing two drilling units, the drillship Discoverer and the semi-submersible Polar Pioneer.

During 2012, Shell drilled a partial well at the Burger A drill site. Burger A did not reach a depth at which a ZVSP survey would be conducted, consequently one was not performed.

An MLC will be constructed at each drill site. The MLCs will be constructed in the seafloor using a large diameter bit operated by hydraulic motors and suspended from the *Discoverer* or *Polar Pioneer*.

(2) Support Vessels

During this exploration drilling program, the Discoverer and Polar Pioneer will be supported by the types of vessels listed in Table 1. These drilling units would be accompanied by an expanded number of support vessels and oil spill response vessels than were deployed by Shell during 2012 exploration drilling in the Chukchi Sea.

Table 1. Chukchi Sea Exploration Drilling Program – Proposed Vessel Types

Specification	Ice Management Vessel (x2)[1]	Anchor Handler (x3)[2]	OSV (x3)[3]	Drilling Discharge Monitoring Science Vessel (x2)[4]	Shallow Water Vessel (x2)[5]	Support Tugs (x2)[6]	Resupply Tug and Barges (x2)[7]	
							Tug	Barge
Length	380 ft. (116 m)	361 ft. (110.1 m)	300 ft. (91.5 m)	300 ft. (91.5 m)	134 ft. (40.8 m)	146 ft. (44.5 m)	150 ft. (45.7 m)	400 ft. (122 m)
Width	85 ft. (26 m)	80 ft. (24.4 m)	60 ft. (18.3 m)	60 ft. (18.3 m)	32 ft. (9.7 m)	46 ft. (14 m)	40 ft. (12.2 m)	99.5 ft. (30.3m)
Draft	27 ft. (8.4 m)	28 ft. (8.5 m)	15.9 ft. (4.9 m)	15.9 ft. (4.9 m)	6 ft. (1.8 m)	21 ft. (6.4 m)	19.5 ft. (5.9 m)	25 ft. (7.6 m)
Accommodations	82	64	50	50	22	13	11	--
Maximum Speed	16 knots (30 km/hr.)	15 knots (28 km/hr.)	13 knots (24 km/hr.)	13 knots (24 km/hr.)	10 knots (18 km/hr.)	16 knots (30 km/hr.)	12 knots (22 km/hr.)	--
Available Fuel Storage	14,192 bbl (2,256m^3)	11,318 bbl (1,799 m^3)	5,786 bbl (920 m^3)	5,786 bbl (920 m^3)	667 bbl (106 m^3)	5,585 bbl (888 m^3)	4,800 bbl (774 m^3)	--

[1] *Based on Nordica or similar vessel*
[2] Based on *Aiviq* or similar vessel
[3] Based on the *Harvey Champion* or similar vessel
[4] Based on the *Harvey Champion* or similar vessel
[5] Based on the *Arctic Seal; Vessels will be located in Kotzebue Sound and not transiting to a drill site*
[6] Based on the tug *Ocean Wave; Tugs will be located in Kotzebue Sound and not transiting to a drill site*
[7] Based on the *Lauren Foss* (tug) and *Tuuq* (barge)

Two ice management vessels will support the drilling units. These vessels will enter and exit the Chukchi Sea with or ahead of the drilling units, and will generally remain in the vicinity of the drilling units during the drilling season. Ice management and ice scouting is expected to occur at distances of 20 mi (32 km) and 30 mi (48 km) respectively. However, these vessels may have to expand beyond these ranges depending on ice conditions.

Up to three anchor handlers will support the drilling units. These vessels will enter and exit the Chukchi Sea with or ahead of the drilling units, and will generally remain in the vicinity of the drilling units during the drilling season. When the vessels are not anchor handling, they will be available to provide other general support. Two of the three anchor handlers may be used to perform secondary ice management tasks if needed.

The planned exploration drilling activities will use three offshore supply vessels (OSVs) for resupply of the drilling units and support vessels. Drilling materials, food, fuel, and other supplies will be picked up in Dutch Harbor (with possible minor resupply coming out of Kotzebue) and transported to the drilling units and support vessels.

Shell plans to use up to two science vessels; one for each drilling unit, from which sampling of drilling discharges would be conducted. The science vessel specifications are based on larger OSVs, but smaller vessels may be used.

Two tugs will tow the *Polar Pioneer* from Dutch Harbor to the Burger Prospect. After the Polar Pioneer is moored, the tugs will remain in the vicinity of the drilling units to help move either drilling unit in the event they need to be moved off of a drilling site due to ice or any other event.

Shell may deploy a MLC ROV system from an OSV type vessel that could be used to construct MLCs prior to a drilling units arriving. If used, this vessel would be located at a drill site on the Burger Prospect. When not in use, the vessel would be outside of the Chukchi Sea lease sale planning area.

(3) Oil Spill Response Vessels

The oil spill response (OSR) vessel types supporting the exploration drilling program are listed in Table 2.

One dedicated OSR barge and on-site oil spill response vessel (OSRV) will be staged in the vicinity of the drilling unit(s) when drilling into potential liquid hydrocarbon bearing zones. This will enable the OSRV to respond to a spill and provide containment, recovery, and storage for the initial response period in the unlikely event of a well control incident.

The OSR barge, associated tug, and OSRV possess sufficient storage capacity to provide containment, recovery, and storage for the initial response period. Shell plans to use two oil storage tankers (OSTs). An OST will be staged at the Burger Prospect. The OST will hold fuel for Shell's drilling units, support vessels, and have space for storage of recovered liquids in the unlikely event of a well control incident. A second OST will be stationed outside the Chukchi Sea lease sale planning area and will be sited such that it will be able to respond to a well control event before the first tanker reaches its recovered liquid capacity.

The tug and barge will be used for nearshore OSR. The nearshore tug and barge will be moored near Goodhope Bay, Kotzebue Sound. The nearshore tug and barge will also carry response equipment, including one 47 ft. (14 m) skimming vessel, 34 ft. (10 m) workboats, mini-barges, boom and duplex skimming units for nearshore recovery and possibly support nearshore protection. The nearshore tug and barge will also carry designated response personnel and will mobilize to recovery areas, deploy equipment and begin response operations.

Table 2. Chukchi Sea Exploration Drilling Program – Proposed Oil Spill Response Vessel Types

Specification	OSR Vessel [1,2]	Offshore OSR [1,3]		Nearshore OSR [1,4,9]		OST [1,5]	OST [1,6,9]	Containment Barge [1,7,9]	
		Tug	Barge	Tug	Barge			Tug	Barge
Length	301 ft. (91.9 m)	126 ft. (38.4 m)	333 ft. (101.5 m)	90 ft. (27.4 m)	205 ft. (62.5 m)	748 ft. (228 m)	813 ft. (248 m)	150 ft. (45.7 m)	316.5 ft. (96.5 m)
Width	60 ft. (18.3 m)	34 ft. (10.4 m)	76 ft. (23.1 m)	32 ft. (9.8 m)	90 ft. (27.4 m)	105 ft. (32 m)	141 ft. (48 m)	40 ft. (12.2 m)	105 ft. (32 m)
Draft	19 ft. (5.8 m)	17 ft. (5.2 m)	22 ft. (6.7 m)	10 ft. (3 m)	15 ft. (4.6 m)	66 ft. (20 m)	69 ft. (21 m)	19.5 ft. (5.9 m)	12.5 ft. (3.8 m)
Accommodations	41	15	--	8	25	25	25	11	72
Maximum Speed	16 knots (30 km/hr.)	12 knots (22 km/hr.)	--	12 knots (22 km/hr.)	--	15 knots (28 km/hr.)	15 knots (28 km/hr.)	10 knots (19 km/hr.)	--
Available Fuel Storage	7,692 bbl (1,223 m^3)	1,786 bbl (284 m^3)	390 bbl (62 m^3)	1,286 bbl (204.5 m^3)	--	16,121 bbl (2,563m^3)	20,241 bbl (3,218 m^3)	4,800 bbl (763 m^3)	6,630 bbl (1,054 m^3)
Available Liquid Storage	12,245 bbl (1,947 m^3)	--	76,900 bbl (12,226 m^3)	--	17,000 bbl (5,183 m^3)	106,000 bbl[8] (16,852 m^3)	670,000bbl (106,518 m^3)	--	--
Workboats	(3) 34 ft. work boats		--	--	(1) skim boat 47 ft. (14 m) (3) work boats 34 ft. (10 m) (4) mini-barges--	--	--	--	--

[1] Or similar vessel
[2] Based on the *Nanuq*
[3] Based on the tug *Guardsman* (tug) and *Klamath* (barge)
[4] based on the *Point Oliktok* (tug) and Endeavor (barge)
[5] Based on a Panamax type tanker
[6] Based on an Aframax type tanker
[7] Based on the *Corbin Foss* (tug), *Arctic Challenger* (barge) and the *Ross Chouest* (anchor handler)
[8] Total available storage is 350,000 bbl; however, 244,000 bbl of ULSD or a fuel with equal or lower sulfur content (used to refuel the drilling units and support vessels) will take up storage space, leaving 106,000 bbl for recovered liquids. Storage space for recovered liquids will increase as fuel is dispensed for refueling.
[9] These vessels will be moored in Kotzebue Sound; however the OST may be moored elsewhere. The remaining vessels will be stationed in the vicinity of the drilling units

(4) Aircraft

Offshore operations will be serviced by up to three helicopters operated out of an onshore support base in Barrow. The helicopters are not yet contracted. Sikorsky S-92s (or similar) will be used to transport crews between the onshore support base, the drilling units and support vessels with helidecks. The helicopters will also be used to haul small amounts of food, materials, equipment, samples and waste between vessels and the shorebase. Approximately 40 Barrow to Burger Prospect round trip flights will occur each week to support the additional crew change necessities for an additional drilling unit, support vessels, and required sampling.

The route chosen will depend on weather conditions and whether subsistence users are active on land or at sea. These routes may be modified depending on weather and subsistence uses.

Shell will also have a dedicated helicopter for Search and Rescue (SAR). The SAR helicopter is expected to be a Sikorsky S-92 (or similar). This aircraft will stay grounded at the Barrow shore base location except during training drills, emergencies, and other non-routine events. The SAR helicopter and crew plan training flights for approximately 40 hr /month.

A fixed wing propeller or turboprop aircraft, such as the Saab 340-B, Beechcraft 1900, or De Havilland Dash 8, will be used to transport crews, materials, and equipment between Wainwright and hub airports such as Barrow or Fairbanks. It is anticipated that there will be one round trip flight every three weeks.

A fixed wing aircraft, Gulfstream Aero-Commander (or similar), will be used for photographic surveys of marine mammals. These flights will take place daily depending on weather conditions. PSO flight paths are located in the Marine Mammal Monitoring and Mitigation Plan (4MP).

An additional Gulfstream Aero Commander may be used to provide ice reconnaissance flights to monitor ice conditions around the Burger Prospect. Typically, the flights will focus on the ice conditions within 50 mi (80 km) of the drill sites, but more extensive ice reconnaissance may occur beyond 50 mi (80 km). These flights will occur at an altitude of approximately 3,000 ft (915 m).

(5) Vertical Seismic Profile

Shell may conduct a geophysical survey referred to as a vertical seismic profile (VSP) survey at each drill site where a well is drilled in 2015. During VSP surveys, an airgun array is deployed at a location near or adjacent to the drilling units, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically a string of them, are then raised up to the next interval in the wellbore and the process is repeated until the entire wellbore has been surveyed. The purpose of the VSP is to gather geophysical information at various depths, which can then be used to tie-in or groundtruth geophysical information from the previous seismic surveys with geological data collected within the wellbore.

Shell will be conducting a particular form of VSP referred to as a zero-offset VSP (ZVSP), in which the sound source is maintained at a constant location near the wellbore (Figure 1-2 in IHA application). Shell may use one of two typical sound sources: (1) a three-airgun array consisting of three, 150 cubic inches (in^3) (2,458 cm^3) airguns, or (2) a two-airgun array consisting of two, 250 in^3 (4,097 cm^3) airguns. Typical receivers would consist of a standard wireline four-level vertical seismic imager (VSI) tool, which has four receivers 50 ft (15.2 m) apart.

A ZVSP survey is normally conducted at each well after total depth is reached, but may be conducted at a shallower depth. For each survey, Shell would deploy the sound source (airgun array) over the side of the Discoverer or Polar Pioneer with a crane, the sound source will be 50-200 ft (15-61 m) from the wellhead depending on crane location, and reach a depth of approximately 10-23 ft (3-7 m) below the water surface. The VSI along with its four receivers will be temporarily anchored in the wellbore at depth.

The sound source will be pressured up to 3,000 pounds per square inch (psi) , and activated 5-7 times at approximately 20-second intervals. The VSI will then be moved to the next interval of the wellbore and re-anchored, after which the airgun array will again be activated 5-7 times. This process will be repeated until the entire wellbore is surveyed. The interval between anchor points for the VSI is usually 200-300 ft (61-91 m). A normal ZVSP survey is conducted over a period of about 10-14 hours depending on the depth of the well and the number of anchoring points.

(6) Ice Management and Forecasting

The exploration drilling program is located in an area characterized by active sea ice movement, ice scouring, and storm surges. In anticipation of potential ice hazards that may be encountered, Shell will implement a Drilling Ice Management Plan (DIMP) to ensure real-time ice and weather forecasting that will identify conditions that could put operations at risk, allowing Shell to modify its activities accordingly.

Shell's ice management fleet will consist of four vessels: two ice management vessels and two anchor handler/icebreakers. Ice management that is necessary for safe operations during Shell's planned exploration drilling program will occur far out in the OCS, remote from the vicinities of any routine marine vessel traffic in the Chukchi Sea, thereby resulting in no threat to public safety or services that occur near to shore. Shell vessels will also communicate movements and activities through the 2015 North Slope Communications Centers (Com Centers). Management of ice will occur during the drilling season predominated by open water, thus it will not contribute to ice hazards, such as ridging, override, or pileup in an offshore or nearshore environment.

The ice-management/anchor handling vessels will manage the ice by deflecting any ice floes that could affect the *Discoverer* or *Polar Pioneer* when they are drilling or anchor mooring buoys even if the drilling units are not anchored at a drill site. When managing ice, the ice management vessels will generally operate upwind of the drilling units, since the wind and currents contribute to the direction of ice movement. Ice reconnaissance or ice scouting forays may occur out to 48.3 km (30 mi) from the drilling units and are conducted by the ice management vessels into ice that may move into the vicinity of exploration drilling activities. This will provide the vessel and shore-based ice advisors with the information required to decide whether or not active ice management is necessary. The actual distances from the drilling units and the patterns of ice management (distances between vessels, and width of the swath in which ice management occurs) will be determined by the ice floe speed, size, thickness, and character, and wind forecast.

Ice floe frequency and intensity is unpredictable and could range from no ice to ice densities that exceed ice-management capabilities, in which case drilling activities might be stopped and the drilling units disconnected from their moorings and moved off site. The Discoverer was disconnected from its moorings once during the 2012 season to avoid a potential encounter with multi-year ice flows of sufficient size to halt activities. Advance scouting of ice primarily north and east of the Burger A well by the ice management vessels did not detect ice of sufficient size or thickness to warrant disconnecting the Discoverer from its moorings during the remainder of the 2012 season. If ice is present, ice management activities may be necessary in early July, at discrete intervals at other times during the season, and towards the end of operations in late October. However, data regarding historic ice patterns in the area of activities indicate that it will not be required throughout the planned 2015 drilling season.

During the 2012 drilling season, a total of seven days of active ice management by vessels occurred in support of Shell's exploration drilling program in the Chukchi Sea.

When ice is present at a drill site, ice disturbance will be limited to the minimum amount needed to allow drilling to continue. First-year ice will be the type most likely to be encountered. The ice-management vessel will be tasked with managing the ice so that it flows easily around the drilling units and their anchor moorings without building up in front of either. This type of ice is managed by the ice-management vessel continually moving back and forth across the drift line, directly up drift of the drilling units and making turns at both ends, or in circular patterns. During ice-management, the vessel's propeller is rotating at approximately 15 to 20% of the vessel's propeller rotation capacity. Ice management occurs with slow movements of the vessel using lower power and therefore slower propeller rotation speed (i.e., lower cavitation), allowing for fewer repositions of the vessel, and thereby reducing cavitation effects in the water. Occasionally, there may be multi-year ice features that would be managed at a much slower speed than that used to manage first-year ice.

As detailed in Shell's DIMP, in 2012 Shell's ice management vessels conducted ice management to protect moorings for the Discoverer after the drilling unit was moved off of the Burger A well. This work consisted of re-directing flows as necessary to avoid potential impact with mooring buoys, without the necessity to break up multi-year ice flowbergs. Actual breaking of ice may need to occur in the event that ice conditions in the immediate vicinity of activities create a safety hazard for the drilling unit, or its moorings. In such a circumstance, operations personnel will follow the guidelines established in the DIMP to evaluate ice conditions and make the formal designation of a hazardous ice alert condition, which would trigger the procedures that govern any actual icebreaking operations. Despite Shell's experience in 2012, historical data relative to ice conditions in the Chukchi Sea in the vicinity of Shell's planned 2015 activities, establishes that there is a low probability for the type of hazardous ice conditions that might necessitate icebreaking (e.g., records of the National Naval Ice Center archives; Shell/SIWAC). The probability could be greater at the beginning and/or the end of the drilling season (early July or late October). For the purposes of evaluating possible impacts of the planned activities, Shell has assumed icebreaking activities for a limited period of time, and estimated incidental exposures of marine mammals from such activities.

2.3 Description of Alternatives

2.3.1 Alternative 1 – Issuance of an Authorization with Mitigation Measures (Preferred Alternative)

Under this alternative, NMFS would issue an IHA under section 101(a)(5)(D) of the MMPA to Shell, allowing the take, by Level B harassment, of small numbers of marine mammal species incidental to conducting an open-water exploration drilling program (which include operation of the drillship, associated support vessels, including icebreakers, and aircraft, and ZVSP survey activities) in the Chukchi Sea during the 2015 Arctic open-water season. In order to reduce impacts on marine mammals to the lowest level practicable, Shell will be required to implement the mitigation, monitoring, and reporting measures described below.

PROPOSED MITIGATION MEASURES

Vessel Based Marine Mammal Monitoring for Mitigation

The objectives of the vessel based marine mammal monitoring are to ensure that impacts to marine mammals and subsistence hunts are minimized, that effects on marine mammals are documented, and that data is collected on the occurrence and distribution of marine mammals in the project area.

The marine mammal monitoring will be implemented by a team of experienced protected species observers (PSOs). The PSOs will be trained biologists and Alaska Native personnel trained as field observers. PSOs will be stationed on both drilling units, ice management vessels, anchor handlers and other drilling support vessels engaged in transit to and between drill sites to monitor for marine mammals. The duties of the PSOs will include: watching for and identifying marine mammals, recording their numbers, recording distances and reactions of marine mammals to exploration drilling activities, initiating mitigation measures when appropriate, and reporting results of the vessel based monitoring program, which will include the estimation of the number of marine mammal "exposures" to sound levels that may result in harassment as stipulated in the IHA.

The vessel based work will provide:

- the basis for real-time mitigation, if necessary, as required by the various permits that Shell receives;
- information needed to estimate the number of "exposures" of marine mammals to sound levels that may result in harassment, which must be reported to NMFS;
- data on the occurrence, distribution, and activities of marine mammals in the areas where drilling activity is conducted;
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the drilling unit during times with and without drilling activity occurring;
- a communication channel to coastal communities including whalers; and
- employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Alaska Native PSOs.

The vessel based monitoring will be operated and administered consistent with monitoring programs conducted during past exploration drilling activities, seismic and shallow hazards surveys, or alternative requirements stipulated in permits issued to Shell. Agreements between Shell and other agencies will also be fully incorporated. PSOs will be provided training through a program approved by the NMFS.

Mitigation Measures during Exploration Drilling Activities

Shell's planned exploration drilling activities incorporate design features and operational procedures aimed at minimizing potential impacts on marine mammals and subsistence hunts. Some of the mitigation design features include:

- timing and locating drilling support activities to avoid interference with the annual subsistence hunt by Chukchi villages;

- conducting pre-season acoustic modeling to establish the appropriate exclusion and disturbance zones;
- vessel based monitoring to implement appropriate mitigation if necessary, and to determine the effects of drilling activities on marine mammals;
- acoustic monitoring of drilling and vessel sounds and marine mammal vocalizations; and
- aerial surveys with photographic equipment over operations and in coastal and nearshore waters with photographic equipment and PSOs to help determine the effects of project activities on marine mammals; and seismic activity mitigation measures during acquisition of the ZVSP surveys.

The potential impacts on marine mammals during drilling activities will be mitigated through the implementation of several vessel-based mitigation measures as necessary.

(1) Exclusion and Disturbance Zones

"Safety radii" or "exclusion zones" for marine mammals around airgun arrays and other impulsive industrial sound sources are often established at the distances within which received levels are ≥180 dB re 1 µPa (rms) for cetaceans and ≥190 dB re 1 µPa (rms) for pinnipeds. These safety criteria are based on a cautionary assumption that exposure to sound energy at lower received levels will not harm these animals or impair their hearing abilities, but that higher received levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur from exposure to sound at distances greater than the exclusion zone (Richardson *et al*. 1995). The NMFS estimates that marine mammals exposed to pulsed airgun sounds with received levels ≥160 dB re 1 µPa (rms) or continuous sounds from vessel activities with received levels ≥120 dB re 1 µPa (rms) have the potential to be disturbed. As a result, these sound level thresholds are currently used by NMFS to estimate when behavioral harassment can occur..

(A) Exploration Drilling Activities

The areas exposed to sounds produced by the drilling units Discoverer and Polar Pioneer were determined by measurements from drilling in 2012 or were modeled by JASCO Applied Sciences. The 2012 measurement of the distance to the 120 dB (rms) threshold for normal drilling activity by the Discoverer was 0.93 mi (1.5 km) while the distance of the ≥120 dB (rms) radius during MLC construction was 5.1 mi (8.2 km).

Measured sound levels for the *Polar Pioneer* were not available. Its sound footprint was estimated with JASCOs Marine Operations Noise Model (MONM) using an average source level derived from a number of reported acoustic measurements of comparable semi-submersible drill units, including the Ocean Bounty (Gales, 1982), SEDCO 708 (Greene, 1986), and Ocean General (McCauley, 1998). The model yielded a propagation range of 0.22 mi (0.35 km) for rms sound pressure levels of 120 dB for the *Polar Pioneer* while drilling at the Burger Prospect.

In addition to drilling and MLC construction, numerous activities in support of exploration drilling produce continuous sounds above 120 dB (rms). These activities in direct support of the moored drilling units include ice management, anchor handling, and supply/discharge sampling vessels using DP thrusters. Detailed sound characterizations for each of these activities are presented in the 2012 Comprehensive Report (LGL *et al*. 2013).

Shell plans to use PSOs onboard the drilling units, ice management, and anchor handling vessels to monitor marine mammals and their responses to industry activities, in addition to initiating mitigation measures.

(B) ZVSP Surveys

Two sound sources have been proposed by Shell for the ZVSP surveys. The first is a small airgun array that consists of three 150 in3 (2,458 cu cm3) airguns for a total volume of 450 in^3 (7,374 cm^3). The second ZVSP sound source consists of two 250 in^3 (4,097 cm^3) airguns with a total volume of 500 in^3 (8,194 cm^3). Sound footprints of the ZVSP airgun array configurations were estimated using JASCO Applied Sciences' Marine Operations Noise Model (MONM). The model results were maximized over all water depths between 9.9 and 23 ft (3 and 7 m) to yield sound level isopleths as a function of range and direction from the source. The 450 in^3 airgun array at a source depth of 23 ft (7 m) yielded the maximum ranges to the ≥190, ≥180, and ≥160 dB (rms) isopleths. The estimated 95th percentile distances to these thresholds were: 190 dB = 558 ft (170 m), 180 dB = 3,018 ft (920 m), and 160 dB = 26,148 ft (7,970 m). These distances were multiplied by 1.5 as a conservative measure, and the resulting radii are shown in Table 3.

PSOs on the drilling units will initially use the radii in Table 3 for monitoring and mitigation purposes during ZVSP surveys. An acoustics contractor will perform direct measurements of the received levels of underwater sound versus distance and direction from the ZVSP array using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable and used to verify (and if necessary adjust) the threshold radii distances during later ZVSP surveys. The mitigation measures to be implemented will include pre-ramp up watches, ramp ups, power downs and shut downs as described below.

Table 3. Estimated distances of the ≥190, 180, and 160, dB (rms) isopleths to be used for mitigation purposes during ZVSP surveys until SSV results are available.

Threshold levels in dB re 1 μPa (rms)	Estimated Distance (m)
≥190	255
≥180	1,380
≥160	11,960

(2) Ramp Ups

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The purpose of a ramp up (or "soft start") is to "warn" cetaceans and pinnipeds in the vicinity of the airguns and to provide time for them to leave the area, thus avoiding any potential injury or impairment of their hearing abilities.

During the proposed ZVSP surveys, the operator will ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start when no airguns have been firing) will begin by firing a single airgun in the array. A full ramp up will not begin until there has been observation of the exclusion zone by PSOs for a minimum of 30 minutes to ensure that no marine mammals are present. The entire exclusion zone must be visible during the 30 minutes leading into to a full ramp up. If the entire exclusion zone is not visible, a ramp up from a cold start cannot begin. If a marine mammal is sighted within the exclusion zone during the 30 minutes prior to ramp up, ramp up will be delayed until the marine mammal is sighted outside of the exclusion zone or is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

(3) Power Downs and Shut Downs

A power down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shut down is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full arrays, but is outside the applicable exclusion zone of the single source. If a marine mammal is sighted within the applicable exclusion zone of the single energy source, the entire array will be shut down (i.e., no sources firing).

PROPOSED MONITORING AND REPORTING MEASURES

Proposed Monitoring Measures

(1) Protected Species Observers

Vessel based monitoring for marine mammals will be done by trained PSOs on both drilling units, ice management and anchor handler vessels throughout the exploration drilling activities to comply with mitigations contained in Shell's IHA and LOA. The observers will monitor the occurrence and behavior of marine mammals near the drilling units, ice management and anchor handling vessels, during all daylight periods during the exploration drilling operation, and during most periods when exploration drilling is not being conducted. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration drilling activities; and documenting exposures to sound levels that may constitute harassment as defined by NMFS.

(A) Number of Observers

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

- 100 percent monitoring coverage during all periods of exploration drilling operations in daylight;
- Maximum of four consecutive hours on watch per PSO; and
- Maximum of approximately 12 hours on watch per day per PSO

PSO teams will consist of trained Alaska Natives and field biologist observers. An experienced field crew leader will be on every PSO team aboard the drilling units, ice management and anchor handling vessels, and other support vessels during the exploration drilling program. The total number of PSOs aboard may decrease later in the season as the duration of daylight decreases. PSOs will help ensure that the vessel communicates with the Communications and Call Centers (Com Centers) in Native villages along the Chukchi Sea coast.

(B) Crew Rotation

Shell anticipates that there will be provisions for crew rotation at least every three to six weeks to avoid observer fatigue. During crew rotations detailed notes will be provided to the incoming crew leader. Other communications such as email, fax, and/or phone communication between the current and oncoming crew leaders during each rotation will also occur when necessary. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

(C) Observer Qualifications and Training

Crew leaders serving as PSOs will have experience from one or more projects with operators in Alaska or the Canadian Beaufort.

Biologist-observers will have previous PSO experience, and crew leaders will be highly experienced with previous vessel-based marine mammal monitoring projects. Resumes for those individuals will be provided to the NMFS for approval. All PSOs will be trained and familiar with the marine mammals of the area. A PSO handbook, adapted for the specifics of the planned Shell drilling program will be prepared and distributed beforehand to all PSOs.

Most observers will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the drilling season. The training sessions will be conducted by marine mammalogists with extensive crew leader experience from previous vessel based seismic monitoring programs in the Arctic.

Primary objectives of the training include:

- review of the 4MPfor this project, including any amendments adopted or specified by NMFS or other agreements in which Shell may elect to participate;
- review of marine mammal sighting, identification, (photographs and videos) and distance estimation methods, including any amendments specified by NMFS in the IHA (if issued);
- review operation of specialized equipment (e.g., reticle binoculars, big eye binoculars, night vision devices, GPS system); and
- review of data recording and data entry systems, including procedures for recording data on mammal sightings, exploration drilling and monitoring activities, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer databases and laptop computers.

(D) PSO Handbook

A PSO Handbook will be prepared for Shell's monitoring program. The Handbook will contain maps, illustrations, and photographs as well as copies of important documents and descriptive text and are intended to provide guidance and reference information to trained individuals who will participate as PSOs. The following topics will be covered in the PSO Handbook:

- summary overview descriptions of the project, marine mammals and underwater sound energy, the 4MP (vessel-based, aerial, acoustic measurements, special studies), the IHA (if issued) and other regulations/permits/agencies, the Marine Mammal Protection Act;
- monitoring and mitigation objectives and procedures, including initial exclusion and disturbance zones;
- responsibilities of staff and crew regarding the4MP;

- instructions for staff and crew regarding the4MP;
- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and drilling data recording, field data sheet;
- use of specialized field equipment (e.g., reticle binoculars, Big-eye binoculars, NVDs, laser rangefinders);
- reticle binocular distance scale;
- table of wind speed, Beaufort wind force, and sea state codes;
- data storage and backup procedures;
- list of species that might be encountered: identification, natural history;
- safety precautions while onboard;
- crew and/or personnel discord; conflict resolution among PSOs and crew;
- drug and alcohol policy and testing;
- scheduling of cruises and watches;
- communications;
- list of field gear provided;
- suggested list of personal items to pack;
- suggested literature, or literature cited;
- field reporting requirements and procedures;
- copies of the IHA and LOA will be made available; and
- areas where vessels cannot operate such as the Ledyard Bay Critical Habitat Unit (LBCHU) and Hana Shoal Walrus Use Area (HSWUA).

(2) Vessel-Based Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the drilling units and support vessels. Ideally this vantage point is an elevated stable platform from which the PSO has an unobstructed 360o view of the water. The observer(s) will scan systematically with the naked eye and 7 x 50 reticle binoculars, supplemented with Big-eye binoculars and night-vision equipment when needed. Personnel on the bridge will assist the marine mammal observer(s) in watching for pinnipeds and cetaceans. New or inexperienced PSOs will be paired with an experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Information to be recorded by marine mammal observers will include the same types of information that were recorded during previous monitoring projects (e.g., Moulton and Lawson 2002; Reiser *et al*. 2011; Bisson *et al*. 2013). When a mammal sighting is made, the following information about the sighting will be carefully and accurately recorded:

- species, group size, age/size/sex categories (if determinable), physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
- behavior when first sighted and after initial sighting;
- heading (if consistent), bearing and distance from observer;
- apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace;

- time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare, on support vessels the distance and bearing to the drilling unit will also be recorded; and
- positions of other vessel(s) in the vicinity of the observer location.

The vessel's position, speed, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7x50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

An electronic database will be used to record and collate data obtained from visual observations during the vessel-based study. The PSOs will enter the data into the custom data entry program installed on field laptops. The data entry program automates the data entry process and reduces data entry errors and maximizes PSO time spent looking at the water. PSOs also have voice recorders available to them. This is another tool that will allow PSOs to maximize time spent focused on the water.

PSO's are instructed to identify animals as unknown when appropriate rather than strive to identify an animal when there is significant uncertainty. PSOs should also provide any sightings cues they used and any distinguishable features of the animal even if they are not able to identify the animal and record it as unidentified. Emphasis will also be placed on recording what was not seen, such as dorsal features.

(A) Monitoring At Night and In Poor Visibility

Night-vision equipment "Generation 3" binocular image intensifiers or equivalent units will be available for use when needed. However, past experience with night-vision devices (NVDs) in the Beaufort Sea and elsewhere indicates that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Moulton and Lawson 2002; Hartin *et al*. 2013).

(B) Specialized Field Equipment

Shell will provide or arrange for the following specialized field equipment for use by the onboard PSOs: reticle binoculars, Big-eye binoculars, GPS unit, laptop computers, night vision binoculars, and possibly digital still and digital video cameras. Big eye binoculars will be mounted and used on key monitoring vessels including the drilling units, ice management vessels and the anchor handler.

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

The observers on the drilling units and support vessels will record their observations directly into computers using a custom software package. 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. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be sent off of the vessel to Anchorage on a daily basis and backed up regularly onto storage devices on the vessel, and stored at separate locations on the vessel. If practicable, hand-written data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data devices 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. If prepared, this statement would be included in the 90-day and comprehensive reports documenting the monitoring work.

PSOs will be able to plot sightings in near real-time for their vessel. Significant sightings from key vessels including drilling units, ice management, anchor handlers and aircraft will be relayed between platforms to keep observers aware of animals that may be in or near the area but may not be visible to the observer at any one time. Emphasis will be placed on relaying sightings with the greatest potential to involve mitigation or reconsideration of a vessel's course (e.g., large group of bowheads, walruses on ice).

Observer training will emphasize the use of “comments” for sightings that may be considered unique or not fully captured by standard data codes. In addition to the standard marine mammal sightings forms, a specialized form was developed for recording traditional knowledge and natural history observations. PSOs will be encouraged to use this form to capture observations related to any aspect of the arctic environment and the marine mammals found within it. Examples might include relationships between ice and marine mammal sightings, marine mammal behaviors, comparisons of observations among different years/seasons, etc. Voice recorders will also be available for observers to use during periods when large numbers of animals may be present and it is difficult to capture all of the sightings on written or digital forms. These recorders can also be used to capture traditional knowledge and natural history observations should individuals feel more comfortable using the recorders rather than writing down their comments. Copies of these records will be available to all observers for reference if they wish to prepare a statement about their observations for reporting purposes. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

(3) Acoustic Monitoring Plan

Exploration drilling, ZVSP, and vessel noise measurements

Exploration drilling sounds are expected to vary significantly over time due to variations in the level of operations and the different types of equipment used at different times onboard the drilling units. The goals of measurements are:

- to quantify the absolute sound levels produced by exploration drilling and to monitor their variations with time, distance and direction from the drilling unit;

- to measure the sound levels produced by vessels while operating in direct support of exploration drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels not measured in 2012; and
- to measure the sound levels produced by an end-of-hole zero-offset vertical seismic profile (ZVSP) survey using a stationary sound source.

Sound characterization and measurements of all exploration drilling activities will be performed using five Autonomous Multichannel Acoustic Recorders (AMAR) deployed on the seabed along the same radial at distances of 0.31, 0.62, 1.2, 2.5 and 5 mi (0.5,1, 2, 4 and 8 km) from each drilling unit. All five recording stations will sample at least at 32 kHz, providing calibrated acoustic measurements in the 5 Hz to 16 kHz frequency band. The logarithmic spacing of the recorders is designed to sample the attenuation of drilling unit sounds with distance. The autonomous recorders will sample through completion of the first well, to provide a detailed record of sounds emitted from all activities. These recorders will be retrieved and their data analyzed and reported in the project's 90-day report.

The deployment of drilling sound monitoring equipment will occur before, or as soon as possible after the *Discoverer* and the *Polar Pioneer* are on site. Activity logs of exploration drilling operations and nearby vessel activities will be maintained to correlate with these acoustic measurements. All results, including back-propagated source levels for each operation, will be reported in the 90-day report.

(A) Vessel Sound Characterization

Vessel sound characterizations will be performed using dedicated recorders deployed at sufficient distances from exploration drilling operations so that sound produced by those activities does not interfere. Three AMAR acoustic recorders will be deployed on and perpendicular to a sail track on which all Shell contracted vessels will transit. This geometry is designed to obtain sound level measurements as a function of distance and direction. The fore and aft directions are sampled continuously over longer distances to 3 and 6 miles (5 and 10 km) respectively, while broadside and other directions are sampled as the vessels pass closer to the recorders.

Vessel sound measurements will be processed and reported in a manner similar to that used by Shell and other operators in the Beaufort and Chukchi Seas during seismic survey operations. The measurements will further be analyzed to calculate source levels. Source directivity effects will be examined and reported. All vessel sound source characterization results, including source levels, will be reported in 1/3-octave bands in the project 90-day report.

(B) Zero-Offset Vertical Seismic Profiling Sound Monitoring

Shell states that it may conduct a geophysical survey referred to as a zero-offset vertical seismic profile, or ZVSP, at two drill sites in 2015. During ZVSP surveys, an airgun array, which is much smaller than those used for routine seismic surveys, is deployed at a location near or adjacent to the drilling unit, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically a string of them, are then raised up to the next interval in the wellbore and the process is repeated until the entire wellbore has been surveyed. The purpose of the ZVSP survey is to gather geophysical information at various depths in the wellbore, which can then be used to tie-in or ground truth geophysical information from the previously collected 2D and 3D seismic surveys with geological data collected within the wellbore.

Shell will conduct a ZVSP surveys in which the sound source is maintained at a constant location near the wellbore. Two sound sources have been proposed by Shell for the ZVSP surveys in 2015. The first is a small airgun array that consists of three 150 in^3 (2,458 cu cm^3) airguns for a total volume of 450 in^3 (7,374 cm^3). The second ZVSP sound source consists of two 250 in^3 (4,097 cm^3) airguns with a total volume of 500 in^3 (8,194 cm^3).

A ZVSP survey is typically conducted at each well after total depth is reached but may be conducted at a shallower depth. For each survey, the sound source (airgun array) would be deployed over the side of the *Discoverer* or the *Polar Pioneer* with a crane. The sound source will be positioned 50-200ft (15-61 m) from the wellhead (depending on crane location), at a depth of ~10-23ft (3-7 m) below the water surface. Receivers will be temporarily anchored in the wellbore at depth. The sound source will be pressured up to 3,000 pounds per square inch (psi), and activated 5-7 times at approximately 20-second intervals. The receivers will then be moved to the next interval of the wellbore and re-anchored, after which the airgun array will again be activated 5-7 times. This process will be repeated until the entire wellbore has been surveyed in this manner. The interval between anchor points for the receiver array is usually 200-300ft (61-91 m). A typical ZVSP survey takes about 10-14 hours to complete per well (depending on the depth of the well and the number of anchoring points in each well).

ZVSP sound verification measurements will be performed using either the AMARs that are deployed for drilling unit sound characterizations, or by JASCO Ocean Bottom Hydrophone (OBH) recorders. The use of AMARS or OBHs depends on the specific timing these measurements will be required by NMFS; the AMARs will not be retrieved until several days after the ZVSP as they are intended to monitor during retrievals of drilling unit anchors and related support activities. If the ZVSP acoustic measurements are required sooner, four OBH recorders would be deployed at the same locations and those could be retrieved immediately following the ZVSP measurement. The ZVSP measurements can be delivered within 120 hours of retrieval and download of the data from either instrument type.

(C) Acoustic Data Analyses

Exploration drilling sound data will be analyzed to extract a record of the frequency-dependent sound levels as a function of time. These results are useful for correlating measured sound energy events with specific survey operations. The analysis provides absolute sound levels in finite frequency bands that can be tailored to match the highest-sensitivity hearing ranges for species of interest. The analyses will also consider sound level integrated through 1-hour durations (referred to as sound energy equivalent level Leq (1-hour). Similar graphs for long time periods will be generated as part of the data analysis performed for indicating drilling sound variation with time in selected frequency bands.

(D) Reporting of Results

Acoustic sound level results will be reported in the 90-day and comprehensive reports for this program. The results reported will include:

- sound source levels for the drilling units and all drilling support vessels;
- spectrogram and band level versus time plots computed from the continuous recordings obtained from the hydrophone systems;
- hourly Leq levels at the hydrophone locations; and
- correlation of exploration drilling source levels with the type of exploration drilling operation being performed. These results will be obtained by observing differences in drilling sound associated with differences in drilling unit activities as indicated in detailed drilling unit logs.

Acoustic "net" array in Chukchi Sea

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

A net array configuration similar to that deployed in 2007–2013 is again proposed. The basic components of this effort consist of autonomous acoustic recorders deployed widely across the US Chukchi Sea during the open water season and then more limited arrays during the winter season. These calibrated systems sample at 16 kHz with 24-bit resolution, and are capable of recording marine mammal sounds and making anthropogenic noise measurements. The net array configuration will include a regional array of 23 AMAR recorders deployed July–October off the four main transect locations: Cape Lisburne, Point Lay, Wainwright and Barrow. All of these offshore systems will capture sounds associated with exploration drilling, where present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. Six additional summer AMAR recorders will be deployed around the Burger drill sites to monitor directional variations and longer-range propagation of drilling-related sounds. These recorders will also be used to examine marine mammal vocalization patterns in vicinity of exploration drilling activities. The regional recorders will be retrieved in early October 2015; acoustic monitoring will continue through the winter with 8 AMAR recorders deployed October 2015–August 2016. The winter recorders will sample at 16 kHz on a 17% duty cycle (40 minutes every 4 hours). The winter recorders deployed in previous years have provided important information about fall and spring migrations of bowhead, beluga, walrus and several seal species.

The Chukchi acoustic net array will produce an extremely large dataset comprising several Terabytes of acoustic data. The analyses of these data require identification of marine mammal vocalizations. Because of the very large amount of data to be processed, the analysis methods will incorporate automated vocalization detection algorithms that have been developed over several years. While the hydrophones used in the net array are not directional, and therefore not capable of accurate localization of detections, the number of vocalizations detected on each of the sensors provides a measure of the relative spatial distribution of some marine mammal species, assuming that vocalization patterns are consistent within a species across the spatial and geographic distribution of the hydrophone array. These results therefore provide information such as timing of migrations and routes of migration for belugas and bowheads.

A second purpose of the Chukchi net array is to monitor the amplitude of exploration drilling sound propagation over a very large area. It is expected that sounds from exploratory drilling activities will be detectable on hydrophone systems within approximately 30 km of the drilling units when ambient sound energy conditions are low. The drilling sound levels at recorder locations will be quantified and reported.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions are to (a) determine when, where, and what species of animals are acoustically detected on each recorder (b) analyze data as a whole to determine offshore distributions as a function of time, (c) quantify spatial and temporal variability in the ambient sound energy, and (d) measure received levels of exploration drilling survey events and drilling unit activities. The detection data will be used to develop spatial and temporal animal detection distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (e.g., time of day, season, environmental conditions, ambient sound energy, and drilling or vessel sound levels).

(4) Chukchi Offshore Aerial Photographic Monitoring Program

Shell has been reticent to conduct manned aerial surveys in the offshore Chukchi Sea because conducting those surveys puts people at risk. There is a strong desire, however, to obtain data on marine mammal distribution in the offshore Chukchi Sea. Shell will conduct a photographic aerial survey that would put fewer people at risk as an alternative to the fully-manned aerial survey. The photographic survey would reduce the number of people on board the aircraft from six persons to two persons (the pilot and copilot) and would serve as a pilot study for future surveys that would use an Unmanned Aerial System (UAS) to capture the imagery.

Aerial photographic surveys have been used to monitor distribution and estimate densities of marine mammals in offshore areas since the mid-1980s, and before that, were used to estimate numbers of animals in large concentration areas. Digital photographs provide many advantages over observations made by people if the imagery has sufficient resolution. With photographs there is constant detectability across the imagery, whereas observations by people decline with distance from the center line of the survey area. Observations at the outer limits of the transect can decline to 5-10% of the animals present for real-time observations by people during an aerial survey. The distance from the trackline of sightings is more accurately determined from photographs; group size can be more accurately determined; and sizes of animals can be measured, and hence much more accurately determined, in photographs. As a result of the latter capability, the presence or absence of a calf can be more accurately determined from a photograph than by in-the-moment visual observations. Another benefit of photographs over visual observations is that photographs can be reviewed by more than one independent observer allowing quantification of detection, identification and group size biases.

The proposed photographic survey will provide imagery that can be used to evaluate the ability of future studies to use the same image capturing systems in an UAS where people would not be put at risk. Although the two platforms are not the same, the slower airspeed and potentially lower flight altitude of the UAS would mean that the data quality would be better from the UAS. Initial comparisons have been made between data collected by human observers on board both the Chukchi and Beaufort aerial survey aircraft and the digital imagery collected in 2012. Overall, the imagery provided better estimates of the number of large cetaceans and pinnipeds present but fewer sightings were identified to species in the imagery than by PSOs, because the PSOs had sightings in view for a longer period of time and could use behavior to differentiate species. The comparisons indicated that some cetaceans that were not seen by PSOs were detected in the imagery; errors in identification were made by the PSOs during the survey that could be resolved from examination of the imagery; cetaceans seen by PSOs were visible in the imagery; and during periods with large numbers of sightings, the imagery provided much better estimates of numbers of sightings and group size than the PSO data.

Photographic surveys would start as soon as the ice management, anchor handler and drilling units are at or near the first drill site and would continue throughout the drilling period and until the drilling related vessels have left the exploration drilling area. Since the current plans are for vessels to enter the Chukchi Sea on or about 1 July, surveys would be initiated on or about 3 July. This start date differs from past practices of beginning five days prior to initiation of an activity and continuing until five days after cessation of the activity because the presence of vessels with helidecks in the area where overflights will occur is one of the main mitigations that will allow for safe operation of the overflight program this far offshore. The surveys will be based out of Barrow and the same aircraft will conduct the offshore surveys around the drilling units and the coastal saw-tooth pattern. The surveys of offshore areas around the drilling units will take precedence over the sawtooth survey, but if weather does not permit surveying offshore, the nearshore survey will be conducted if weather permits.

The aerial survey grids are designed to maximize coverage of the sound level fields of the drilling units during the different exploratory drilling activities. The survey grids can be modified as necessary based on weather and whether a noisy activity or quiet activity is taking place. The intensive survey design maximizes the effort over the area where sound levels are highest. The outer survey grid covers an elliptical area with a 45 km radius near the center of the ellipse. The spacing of the outer survey lines is 10 km, and the spacing between the intensive and outer lines is 5 km. The expanded survey grid covers a larger survey area, and the design is based on an elliptical area with a 50 km radius centered on the well sties. For both survey designs the main transects will be spaced 10 km apart which will allow even coverage of the survey area during a single flight if weather conditions permit completion of a survey. A random starting point will be selected for each survey and the evenly spaced lines will be shifted NE or SW along the perimeter of the elliptical survey area based on the start point. The total length of survey lines will be about 1,000 km and the exact length will depend on the location of the randomly selected start point.

Following each survey, the imagery will be downloaded from the memory card to a portable hard drive and then backed up on a second hard drive and stored at accommodations in Barrow until the second hard drive can be transferred to Anchorage. In Anchorage, the imagery will be processed through a computer-assisted analysis program to identify where marine mammal sightings might be located among the many images obtained. A team of trained photo analysts will review the photographs identified as having potential sightings and record the appropriate data on each sighting. If time permits, a second review of some of the images will be conducted while in the field, but the sightings recorded during the second pass will be identified in the database as secondary sightings, so that biases associated with the detection in the imagery can be quantified. If time does not permit that review to be conducted while in the field, the review will be conducted by personnel in the office during or after the field season. A sample of images that are not identified by the computer-assisted analysis program will be examined in detail by the image analysts to determine if the program has missed marine mammal sightings. If the analysis program has missed mammal sightings, these data will be to develop correction factors to account for these missed sightings among the images that were not examined.

(5) Chukchi Sea Coastal Aerial Survey

Nearshore aerial surveys of marine mammals in the Chukchi Sea were conducted over coastal areas to approximately 23 miles (mi) [37 kilometers (km)] offshore in 2006–2008 and in 2010 in support of Shell's summer seismic exploration activities. In 2012 these surveys were flown when it was not possible to fly the photographic transects out over the Burger well site due to weather or rescue craft availability. These surveys provided data on the distribution and abundance of marine mammals in nearshore waters of the Chukchi Sea. Shell plans to conduct these nearshore aerial surveys in the Chukchi Sea as opportunities unfold and surveys will be similar to those conducted during previous years except that no PSOs will be onboard the aircraft. As noted above, the first priority will be to conduct photographic surveys around the offshore exploration drilling activities, but nearshore surveys will be conducted whenever weather does not permit flying offshore. As in past years, surveys in the southern part of the nearshore survey area will depend on the end of the beluga hunt near Point Lay. In past years, Point Lay has requested that aerial surveys not be conducted until after the beluga hunt has ended and so the start of surveys has been delayed until mid-July.

Alaskan Natives from villages along the east coast of the Chukchi Sea hunt marine mammals during the summer and Native communities are concerned that offshore oil and gas exploration activities may negatively impact their ability to harvest marine mammals. Of particular concern are potential impacts on the beluga harvest at Point Lay and on future bowhead harvests at Point Hope, Point Lay, Wainwright and Barrow. Other species of concern in the Chukchi Sea include the gray whale; bearded, ringed, and spotted seals; and walrus. Gray whale and harbor porpoise are expected to be the most numerous cetacean species encountered during the proposed aerial survey; although harbor porpoise are abundant they are difficult to detect from aircraft because of their small size and brief surfacing. Beluga whales may occur in high numbers early in the season. The ringed seal is likely to be the most abundant pinniped species. The current aerial survey program will be designed to collect distribution data on cetaceans but will be limited in its ability to collect similar data on pinnipeds and harbor porpoises because they are not reliably detectable during review of the collected images unless a third camera with a 50 mm or similar lens is deployed.

Transects will be flown in a saw-toothed pattern between the shore and 23 mi (37 km) offshore as well as along the coast from Point Barrow to Point Hope. This design will permit completion of the survey in one to two days and will provide representative coverage of the nearshore region. Sawtooth transects were designed by placing transect start/end points every 34 mi (55 km) along the offshore boundary of this 23 mi (37 km) wide nearshore zone, and at midpoints between those points along the coast. The transect line start/end points will be shifted along both the coast and the offshore boundary for each survey based upon a randomized starting location, but overall survey distance will not vary substantially. The coastline transect will simply follow the coastline or barrier islands. As with past surveys of the Chukchi Sea coast, coordination with coastal villages to avoid disturbance of the beluga whale subsistence hunt will be extremely important. "No-fly" zones around coastal villages or other hunting areas established during communications with village representatives will be in place until the end of the hunting season.

Standard aerial survey procedures used in previous marine mammal projects (by Shell as well as by others) will be followed. This will facilitate comparisons and (as appropriate) pooling with other data, and will minimize controversy about the chosen survey procedures. The aircraft will be flown at 110–120 knots ground speed and usually at an altitude of 1,000 ft (305 m). Aerial surveys at an altitude of 1,000 ft. (305 m) do not provide much information about seals but are suitable for bowhead, beluga, and gray whales. The need for a 1,000+ ft (305+ m) or 1,500+ ft (454+ m) cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher altitude for surveys would result in a significant reduction in the number of days during which surveys would be possible, impairing the ability of the aerial program to meet its objectives.

The surveyed area will include waters where belugas are usually available to subsistence hunters. If large concentrations of belugas are encountered during the survey, the aircraft will climb to ~10,000 ft (3,050 m) altitude to avoid disturbing the cetaceans. If cetaceans are in offshore areas, the aircraft will climb high enough to include all cetaceans within a single photograph; typically about 3,000 ft (914 m) altitude. When in shallow water, belugas and other marine mammals are more sensitive to aircraft over flights and other forms of disturbance than when they are offshore (see Richardson et al. 1995 for a review). They frequently leave shallow estuaries when over flown at altitudes of 2,000–3,000 ft (610-904 m); whereas they rarely react to aircraft at 1,500 ft (457 m) when offshore in deeper water.

Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS' implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR 216.108(d)).

NMFS has established an independent peer review panel to review Shell's 4MP for Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea in 2015. The panel is scheduled to meet in early March 2015, and will provide comments to NMFS shortly after they meet. After completion of the peer review, NMFS will consider all recommendations made by the panel, incorporate appropriate changes into the monitoring requirements of the IHA (if issued), and publish the panel's findings and recommendations in the final IHA notice of issuance or denial document.

Reporting Measures

(1) Field Reports

Throughout the exploration drilling program, the biologists will prepare a report each day or at such other interval as required summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS as required.

(2) Technical Reports

The results of Shell's 2015 Chukchi Sea exploratory drilling monitoring program (i.e., vessel-based, aerial, and acoustic) will be presented in the "90-day" and Final Technical reports, as required by NMFS under the proposed IHA. Shell proposes that the Technical Reports will include: (1) summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals); (2) analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare); (3) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover; (4) sighting rates of marine mammals during periods with and without drilling activities (and other variables that could affect detectability); (5) initial sighting distances versus drilling state; (6) closest point of approach versus drilling state; (7) observed behaviors and types of movements versus drilling state; (8) numbers of sightings/individuals seen versus drilling state; (9) distribution around the drillship and support vessels versus drilling state; and (10) estimates of take by harassment. This information will be reported for both the vessel-based and aerial monitoring.

Analysis of all acoustic data will be prioritized to address the primary questions, which are to: (a) determine when, where, and what species of animals are acoustically detected on each Directional Autonomous Seafloor Acoustic Recorder; (b) analyze data as a whole to determine offshore bowhead distributions as a function of time; (c) quantify spatial and temporal variability in the ambient noise; and (d) measure received levels of drillship activities. The bowhead detection data will be used to develop spatial and temporal animal distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (e.g., time of day, time of season, environmental conditions, ambient noise, vessel type, operation conditions).

The initial technical report is due to NMFS within 90 days of the completion of Shell's Chukchi Sea exploration drilling program. The "90-day" report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS.

(3) Notification of Injured or Dead Marine Mammals

Shell will be required to notify NMFS' Office of Protected Resources and NMFS' Stranding Network of any sighting of an injured or dead marine mammal. Based on different circumstances, Shell may or may not be required to stop operations upon such a sighting. Shell will provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

2.3.2 Alternative 2 – Issuance of an IHA for a Shorter Time Period with Required Mitigation, Monitoring, and Reporting Requirements

Under this alternative, NMFS would issue an IHA under section 101(a)(5)(D) of the MMPA to Shell, allowing the take by harassment of small numbers of marine mammal species incidental to conducting an open-water exploration drilling program (which include operation of the drillship, associated support vessels, including icebreakers, and aircraft, and ZVSP survey activities) in the Chukchi Sea during the 2015 Arctic open-water season. Shell's MMPA application to NMFS for an IHA requested that takes of marine mammals incidental to conducting the proposed exploration drilling programs be allowed to occur through October 31. Under Alternative 2, activities in the Chukchi Sea would need to cease by the end of September instead of the end of October. The same mitigation and monitoring measures to reduce impacts to marine mammals and the availability of marine mammals for subsistence uses would be required as in Alternative 1, as well as the same reporting requirements. Since the MMPA requires holders of IHAs to reduce impacts on marine mammals to the lowest level practicable and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses, implementation of this alternative will meet NMFS' purpose and need as described in this EA.

2.3.3 Alternative 3 – Issuance of an IHA to Drill One Well with Required Mitigation, Monitoring, and Reporting Requirements

Under Alternative 3, NMFS would issue an IHA under section 101(a)(5)(D) of the MMPA to Shell, allowing the take by harassment of small numbers of marine mammal species incidental to conducting open-water exploration drilling program (which include operation of the drillship, associated support vessels, including icebreakers, and aircraft, and ZVSP survey activities) in the Chukchi Sea during the 2015 Arctic open-water season. However, instead of being authorized for the take associated with drilling up to four wells in the Chukchi Sea, the IHAs would only authorize take associated with drilling one complete well (drilled to total depth). The IHA would, however, authorize take associated with other aspects of the programs, such as ZVSP surveys and MLC construction, throughout the entire open-water season (i.e., July through October) for other wells. The only difference with those wells is that Shell would not be allowed to access the hydrocarbon bearing zones of those additional wells in that season. The same mitigation and monitoring measures to reduce impacts to marine mammals and the availability of marine mammals for subsistence uses would be required as in Alternative 1, as well as the same reporting requirements. Since the MMPA requires holders of IHAs to reduce impacts on marine mammals to the lowest level practicable and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses, implementation of this alternative will meet NMFS' purpose and need as described in this EA.

2.3.4 Alternative 4 – No Action Alternative

Under the No Action Alternative, NMFS would not issue the requested IHA to Shell for the potential take of marine mammals, by harassment, incidental to conducting an exploration drilling program in the U.S. Chukchi Seas during the 2015 open-water season. The MMPA prohibits all takings of marine mammals unless authorized by a permit or exemption under the MMPA. The consequences of not authorizing incidental takes are (1) the entity conducting the activity may be in violation of the MMPA if takes do occur, (2) mitigation and monitoring measures cannot be required by NMFS, and (3) mitigation measures might not be performed voluntarily by the applicant. While NMFS does not authorize the oil and gas exploration drilling activities themselves (that authority falls to BOEM), NMFS does authorize the unintentional, incidental take of marine mammals (under its jurisdiction) in connection with these activities and prescribes, where applicable, the methods of taking and other means of effecting the least practicable impact on the species and stocks and their habitats. If an IHA is not issued, Shell would effectively be precluded from engaging in exploration drilling operations in the U.S. Chukchi Seas during the 2015 open-water season, as approval of the exploration plans by BOEM is contingent upon Shell receiving an IHA from NMFS. The No Action Alternative would meet NMFS' purpose and need only if based on the information before us we could not make one or more of the required determinations. CEQ's regulations require consideration and analysis of a No Action Alternative for the purposes of presenting a comparative analysis to the action alternatives.

2.3.5 Alternatives Considered but Rejected from Further Consideration

NMFS considered whether other alternatives could meet the purpose and need and support Shell's proposed activities.

Issuance of IHAs with No Required Mitigation, Monitoring, or Reporting Measures

An alternative that would allow for the issuance of IHAs with no required mitigation or monitoring was considered but eliminated from consideration, as it would not be in compliance with the MMPA and therefore would not meet the purpose and need. For that reason, this alternative is not analyzed further in this document.

Use of Alternative Technologies

An alternative that would require Shell to use alternative technologies to explore the mineral potential of Shell's proposed lease tracts at the Burger prospect in the Chukchi Sea was considered but eliminated from further consideration. NMFS is unaware of any alternative techniques currently available that would allow Shell to conduct the two proposed exploration drilling programs in the U.S. Arctic Ocean. Shell's proposed exploration drilling programs use the safest techniques known for determining whether a site is capable of producing hydrocarbons in sufficient quantities to justify commercial development.

Chapter 3 AFFECTED ENVIRONMENT

This chapter describes existing conditions in the proposed action areas. Complete descriptions of the physical, biological, and social environment of the action area are contained in the documents listed in Section 1.3.1 of this EA. We incorporate those descriptions by reference and briefly summarize or supplement the relevant sections for marine mammals in the following subchapters.

3.1 Physical Environment

We are required to consider impacts to the physical environment under NOAA NAO 216-6. As discussed in Chapter 1, our proposed action and alternatives relate only to the authorization of incidental take of marine mammals and not to the physical environment. Certain aspects of the physical environment are not relevant to our proposed action (see subchapter 1.3.2 - Scope of Environmental Analysis). Because of the requirements of NAO 216-6, we briefly summarize the physical components of the environment here.

3.2 Biological Environment

The primary component of the biological environment that would be impacted by the proposed action and alternatives would be marine mammals, which would be directly impacted by the authorization of incidental take. We briefly summarize this component of the biological environment here.

3.2.1 Marine Mammals

We provide information on the occurrence of marine mammals most likely present in the proposed activity areas in section 1.1.2 of this EA. The marine mammals most likely to be harassed incidental to Shell's exploration drilling in the Chukchi Sea are: beluga whales, killer whales, harbor porpoises, bowhead whales, fin whales, gray whales, humpback whales, minke whales, bearded seals, ribbon seals, ringed seals, and spotted seals. Bowhead whales, fin whales, humpback whales, and ringed seals are listed under the Endangered Species Act (ESA).

The Chukchi Sea supports a diverse assemblage of marine mammals, including: bowhead, gray, beluga, killer, minke, humpback, and fin whales; harbor porpoise; ringed, ribbon, spotted, and bearded seals; narwhals; polar bears (*Ursus maritimus*); and walruses (*Odobenus rosmarus divergens*). The bowhead, humpback, and fin whales are listed as "endangered" under the Endangered Species Act (ESA) and as depleted under the MMPA. The ringed and bearded eal is listed as "threatened" under the ESA. Certain stocks or populations of gray, beluga, and killer whales and spotted seals are listed as endangered or are proposed for listing under the ESA; however, none of those stocks or populations occur in the proposed activity area. Both the walrus and the polar bear are managed by the U.S. Fish and Wildlife Service (USFWS) and are not considered further in this proposed IHA notice.

Of these species, 12 are expected to occur in the area of Shell's proposed operations. These species include: the bowhead, gray, humpback, minke, fin, killer, and beluga whales; harbor porpoise; and the ringed, spotted, bearded, and ribbon seals. Beluga, bowhead, and gray whales, harbor porpoise, and ringed, bearded, and spotted seals are anticipated to be encountered more than the other marine mammal species mentioned here. The marine mammal species that is likely to be encountered most widely (in space and time) throughout the period of the proposed drilling program is the ringed seal. Encounters with bowhead and gray whales are expected to be limited to particular seasons, as discussed later in this document.

The narwhal occurs in Canadian waters and occasionally in the Alaskan Beaufort Sea and the Chukchi Sea, but it is considered extralimital in U.S. waters and is not expected to be encountered. There are scattered records of narwhal in Alaskan waters, including reports by subsistence hunters, where the species is considered extralimital (Reeves *et al.* 2002). Due to the rarity of this species in the proposed project area and the remote chance it would be affected by Shell's proposed Chukchi Sea drilling activities, this species is not discussed further in this document.

Shell's IHA application (Shell, 2014a) contains information on the status, distribution, seasonal distribution, abundance, and life history of each of the species under NMFS jurisdiction mentioned in this document. When reviewing the IHA application, NMFS determined that the species descriptions provided by Shell correctly characterized the status, distribution, seasonal distribution, and abundance of each species. Please refer to the IHA application for that information. Additional information can also be found in the NMFS Stock Assessment Reports (SAR). The Alaska 2013 SAR is available at:
http://www.nmfs.noaa.gov/pr/sars/pdf/ak2013_final.pdf.

Table 4 lists the 12 marine mammal species under NMFS jurisdiction with confirmed or possible occurrence in the proposed project area.

3.3 Socioeconomic Environment

3.3.1 Subsistence

The disturbance and potential displacement of marine mammals by sounds from drilling activities are the principal concerns related to subsistence use of the area. Subsistence remains the basis for Alaska Native culture and community. Marine mammals are legally hunted in Alaskan waters by coastal Alaska Natives. In rural Alaska, subsistence activities are often central to many aspects of human existence, including patterns of family life, artistic expression, and community religious and celebratory activities. Additionally, the animals taken for subsistence provide a significant portion of the food that will last the community throughout the year. The main marine mammal species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses, and polar bears. (As mentioned previously in this document, both the walrus and the polar bear are under the USFWS' jurisdiction.) The importance of each of these species varies among the communities and is largely based on availability.

The subsistence communities in the Chukchi Sea that have the potential to be impacted by Shell's offshore drilling program include Point Hope, Point Lay, Wainwright, Barrow, and possibly Kotzebue and Kivalina (however, these two communities are much farther to the south of the proposed project area).

Table 4. Marine mammal species and stocks with confirmed or possible occurrence in the proposed exploration drilling area.

Common Name	Scientific Name	Status	Occurrence	Seasonality	Range	Abundance
Odontocetes Beluga whale (Eastern Chukchi Sea stock)	Dephinapterus leucas	-	Common	Mostly spring and fall with some in summer	Russia to Canada	3,710
Beluga whale (Beaufort Sea stock)	Delphinapterus leucas	-	Common	Mostly spring and fall with some in summer	Russia to Canada	39,258
Killer whale	Orcinus orca	-	Occasional/ Extralimital	Mostly summer and early fall	California to Alaska	2,084
Harbor porpoise	Phocoena phocoena	-	Occasional/ Extralimital	Mostly summer and early fall	California to Alaska	48,215
Mysticetes Bowhead whale	Balaena mysticetus	Endangered; Depleted	Common	Mostly spring and fall with some in summer	Russia to Canada	19,534
Gray whale	Eschrichtius robustus	-	Somewhat common	Mostly summer	Mexico to the U.S. Arctic Ocean	19,126
Minke whale	Balaenoptera acutorostrata	-	Rare	Summer		810-1,003
Fin whale (North Pacific stock)	B. physalus	Endangered; Depleted	Rare	Summer		1,652
Humpback whale (Central North Pacific stock)	Megaptera novaeangliae	Endangered; Depleted	Rare	Summer		20,800
Pinnipeds Bearded seal (Beringia distinct population segment)	Erigathus barbatus	Candidate	Common	Spring and summer	Bering, Chukchi, and Beaufort Seas	155,000
Ringed seal (Arctic stock)	Phoca hispida	Threatened; Depleted	Common	Year round	Bering, Chukchi, and Beaufort Seas	300,000
Spotted seal	Phoca largha	-	Common	Summer	Japan to U.S. Arctic Ocean	141,479
Ribbon seal	Histriophoca fasciata	Species of concern	Occasional	Summer	Russia to U.S. Arctic Ocean	49,000

(1) Bowhead Whales

Bowhead hunts by residents of Wainwright, Point Hope and Point Lay take place almost exclusively in the spring prior to the date on which Shell would commence the proposed exploration drilling program. From 1984 through 2009, all bowhead harvests by these Chukchi Sea villages occurred only between April 14 and June 24 (George and Tarpley 1986; George et al. 1987, 1988, 1990, 1992, 1995, 1998, 1999, 2000; Philo et al. 1994; Suydam et al. 1995, 1996, 1997, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010), while Shell will not enter the Chukchi Sea prior to July 1. However, fall whaling by some of these Chukchi Sea villages has occurred since 2010 and is likely to occur in the future, particularly if bowhead quotas are not completely filled during the spring hunt, and fall weather is accommodating. A Wainwright whaling crew harvested the first fall bowhead for these villages in 90 years or more on October 7, 2010, and another in October of 2011 (Suydam et al. 2011, 2012, 2013). No bowhead whales were harvested during fall in 2012, but 3 were harvested by Wainwright in fall 2013.

Barrow crews have traditionally hunted bowheads during both spring and fall; however spring whaling by Barrow crews is normally finished before the date on which Shell operations would commence. From 1984 through 2011 whales were harvested in the spring by Barrow crews only between April 23 and June 15 (George and Tarpley 1986; George et al. 1987, 1988, 1990, 1992, 1995, 1998, 1999, 2000; Philo et al. 1994; Suydam et al. 1995, 1996, 1997, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2103). Fall whaling by Barrow crews does take place during the time period when vessels associated with Shell's exploration drilling program would be in the Chukchi Sea. From 1984 through 2011, whales were harvested in the fall by Barrow crews between August 31 and October 30, indicating that there is potential for vessel traffic to affect these hunts. Most fall whaling by Barrow crews, however, takes place east of Barrow along the Beaufort Sea coast therefore providing little opportunity for vessel traffic associated with Shell's exploration drilling program to affect them. For example, Suydam et al. (2008) reported that in the previous 35 years, Barrow whaling crews harvested almost all their whales in the Beaufort Sea to the east of Point Barrow. Shell's mitigation measures, which include a system of Subsistence Advisors (SAs), Community Liaisons, and Com Centers; will be implemented to avoid any effects from vessel traffic on fall whaling in the Chukchi Sea by Barrow and Wainwright.

Aircraft traffic (helicopters and small fixed wing airplanes) between the drill sites and facilities in Wainwright and Barrow would also traverse these subsistence areas. Flights between the drill sites and Wainwright or other shoreline locations would take place after the date on which spring bowhead whaling out of Point Hope, Point Lay, and Wainwright is typically finished for the year; however, Wainwright has harvested bowheads in the fall since 2010 and aircraft may traverse areas sometimes utilized for these fall hunts. Aircraft overflights between the drill sites and Barrow or other shoreline locations could also occur over areas used by Barrow crews during fall whaling, but again, most fall whaling by Barrow crews takes place to the east of Barrow in the Beaufort Sea. The most commonly observed reactions of bowheads to aircraft traffic are hasty dives, but changes in orientation, dispersal, and changes in activity are sometimes noted. Such reactions could potentially affect subsistence hunts if the flights occurred near and at the same time as the hunt, but Shell has developed and proposes to implement a number of mitigation measures to avoid such impacts. These mitigation measures include minimum flight altitudes, employment of SAs, and Com Centers. Twice-daily calls are held during the exploration drilling program and are attended by operations staff, logistics staff, and SAs. Vessel movements and aircraft flights are adjusted as needed and planned in a manner that avoids potential impacts to bowhead whale hunts and other subsistence activities.

(2) Beluga Whale

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

Belugas typically represent a much greater proportion of the subsistence harvest in Point Lay and Point Hope. Point Lay's primary beluga hunt occurs from mid-June through mid-July, but can sometimes continue into August if early success is not sufficient. Point Hope residents hunt beluga primarily in the lead system during the spring (late March to early June) bowhead hunt, but also in open water along the coastline in July and August. Belugas are harvested in coastal waters near these villages, generally within a few miles from shore. Shell's proposed drill sites are located more than 60 mi (97 km) offshore, therefore proposed exploration drilling in the Burger Prospect would have no or minimal impacts on beluga hunts. Aircraft and vessel traffic between the drill sites and support facilities in Wainwright, and aircraft traffic between the drill sites and air support facilities in Barrow would traverse areas that are sometimes used for subsistence hunting of belugas.

Disturbance associated with vessel and aircraft traffic could therefore potentially affect beluga hunts. However, all of the beluga hunt by Barrow residents in the Chukchi Sea, and much of the hunt by Wainwright residents would likely be completed before Shell activities would commence. Additionally, vessel and aircraft traffic associated with Shell's planned exploration drilling program will be restricted under normal conditions to designated corridors that remain onshore or proceed directly offshore thereby minimizing the amount of traffic in coastal waters where beluga hunts take place. The designated vessel and aircraft traffic corridors do not traverse areas indicated in recent mapping as utilized by Point Lay or Point Hope for beluga hunts, and avoids important beluga hunting areas in Kasegaluk Lagoon that are used by Wainwright. Shell has developed and proposes to implement a number of mitigation measures, e.g., PSOs on board vessels, minimum flight altitudes, and the SA and Com Center programs, to ensure that there is no impact on the availability of the beluga whale as a subsistence resource.

(3) Pinnipeds

Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring before Shell's exploration drilling program would commence, but some harvest continues during open water and could possibly be affected by Shell's planned activities. Spotted seals are also harvested during the summer. Most seals are harvested in coastal waters, with available maps of recent and past subsistence use areas indicating seal harvests have occurred only within 30-40 mi (48-64 km) of the coastline. Shell's planned drill sites are located more than 64 statute mi (103 km) offshore, so activities within the Burger Prospect, such as drilling, would have no impact on subsistence hunting for seals. Helicopter traffic between land and the offshore exploration drilling operations could potentially disturb seals and, therefore, subsistence hunts for seals, but any such effects would be minor and temporary lasting only minutes after the flight has passed due to the small number of flights and the altitude at which they typically fly, and the fact that most seal hunting is done during the winter and spring when the exploration drilling program is not operational. Mitigation measures to be implemented by Shell include minimum flight altitudes, employment of subsistence advisors in the villages, and operation of Com Centers.

Chapter 4 ENVIRONMENTAL CONSEQUENCES

This chapter of the EA analyzes the impacts of the four alternatives and addresses the potential direct, indirect, and cumulative impacts of our issuance of an IHA. Shell's application and other related environmental analyses identified previously facilitate this analysis.

Under the MMPA, we have evaluated the potential impacts of Shell's exploration drilling program in order to determine whether to authorize incidental take of marine mammals. Under NEPA, we have determined that an EA is appropriate to evaluate the potential significance of environmental impacts resulting from the issuance of an IHA.

4.1 Effects of Alternative 1— Issuance of an IHA with Mitigation, Monitoring, and Reporting Measures (Preferred Alternative)

Under this alternative, NMFS would issue an IHA to Shell for the proposed exploration drilling program in the Chukchi Sea during the 2015 Arctic open-water season with required mitigation, monitoring, and reporting requirements as discussed in Chapter 2 of this EA. As part of NMFS' action, the mitigation and monitoring described later in this EA would be undertaken as required by the MMPA, and, as a result, no injury or mortality of marine mammals is expected and no adverse impact on the annual reproductive or survival rates of affected species would occur. Potentially affected marine mammal species under NMFS' jurisdiction include: bowhead, beluga, killer, gray, minke, fin, and humpback whales; harbor porpoise; and bearded, spotted, ringed, and ribbon seals. Three of these species (i.e., bowhead, humpback, and fin whales) are listed as endangered under the ESA, and species (ringed seal) is listed as threatended under the ESA.

4.1.1 Effects on Marine Mammals

Noise exposure, habitat degradation, and vessel activity, which could possibly lead to ship strikes, are the primary mechanisms by which activities associated with exploration drilling programs in the Beaufort and Chukchi Seas could directly or indirectly affect marine mammals. The impacts of anthropogenic noise on marine mammals has been summarized in numerous articles and reports including Richardson et al. (1995a), Cato et al. (2004), NRC (2003a, 2005), Southall et al. (2007), Nowacek et al. (2007), and Weilgart (2007). Because the occurrence of a large oil spill is a highly unlikely event, it is not part of the proposed action for any alternative. However, in the highly unlikely event a large spill were to occur, it could result in adverse impacts on marine mammals. The oil spill analysis is not contained in the sections that analyze direct and indirect effects of the alternatives on marine mammals; rather, it is discussed and analyzed separately in Section 4.6 of this EA since an oil spill is not a component of the proposed action.

4.1.1.1 Effects of Noise on Marine Mammals

Background on Sound

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or kilohertz (kHz), while sound level describes the sound's intensity and is measured in decibels (dB). Sound level increases or decreases exponentially with each dB of change. The logarithmic nature of the scale means that each 10-dB increase is a 10-fold increase in acoustic power (and a 20-dB increase is then a 100-fold increase in power). A 10-fold increase in acoustic power does not mean that the sound is perceived as being 10 times louder, however. Sound levels are compared to a reference sound pressure (micro-Pascal) to identify the medium. For air and water, these reference pressures are "re 20 µPa" and "re 1 µPa," respectively. Root mean square (RMS) is the quadratic mean sound pressure over the duration of an impulse. RMS is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). RMS accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part, because behavioral effects, which often result from auditory cues, may be better expressed through averaged units rather than by peak pressures.

Exploration Drilling Program Sound Characteristics

(1) Drilling Sounds

Exploration drilling will be conducted from the drilling units *Discoverer* and *Polar Pioneer*. Underwater sound propagation during the activities results from the use of generators, drilling machinery, and the drilling units themselves. Sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene 1987b), and underwater sound appeared to be lower at the bow and stern aspects than at the beam (Greene 1987a).

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hz although tones up to 1,850 Hz were recorded by Greene (1987a) during drilling operations in the Beaufort Sea. At a range of 0.17 km, the 20-1000 Hz band level was 122-125 dB re 1µPa rms for the drillship *Explorer I*. Underwater sound levels were slightly higher (134 db re 1µPa rms) during drilling activity from the *Explorer II* at a range of 0.20 km; although tones were only recorded below 600 Hz. Underwater sound measurements from the *Kulluk* in 1986 at 0.98 km were higher (143 dB re 1µPa rms) than from the other two vessels. Measurements of the *Discoverer* on the Burger prospect in 2012, without any support vessels operating nearby, showed received sound levels of 120 dB re 1 µPa rms at 1.5 km. The *Polar Pioneer*, a semi-submersible drilling unit, is expected to introduce less sound into the water than the *Discoverer* during drilling and related activities.

(2) Airgun Sounds

Two sound sources have been proposed by Shell for the ZVSP surveys in 2015. The first is a small airgun array that consists of three 150 in^3 (2,458 cm^3) airguns for a total volume of 450 in^3 (7,374 cm^3). The second ZVSP sound source consists of two 250 in^3 (4097 cm^3) airguns with a total volume of 500 in^3 (8,194 cm^3). Typically, a single ZVSP survey will be performed when the well has reached PTD or final depth although, in some instances, a prior ZVSP will have been performed at a shallower depth. A typical survey, would last 10–14 hours, depending on the depth of the well and the number of anchoring points, and include firings of up to the full array, plus additional firing of the smallest airgun in the array to be used as a “mitigation airgun” while the geophones are relocated within the wellbore.

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. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. A typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain energy up to 500–1000 Hz and some energy at higher frequencies (Goold and Fish 1998; Potter et al. 2007).

(3) Aircraft Noise

Helicopters may be used for personnel and equipment transport to and from the drilling units and support vessels. Under calm conditions, rotor and engine sounds are coupled into the water within a 26^{o} cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26º area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in the shallow water.

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. Helicopters flying to and from the drilling units will generally maintain straight-line routes at altitudes of 1,500 ft. (457 m) above sea level, thereby limiting the received levels at and below the surface.

(4) Vessel Noise

In addition to the drilling units, various types of vessels will be used in support of the operations including ice management vessels, anchor handlers, OSVs, and OSR vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007. For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB re 1 µPa rms at distances ranging from ~1.5 to 2.3 mi (~2.4 to 3.7 km) from various types of barges. MacDonnell et al. (2008) estimated higher underwater sound pressure levels from the seismic vessel <u>Gilavar</u> of 120 dB re 1 µPa rms at ~13 mi (~21 km) from the source, although the sound level was only 150 dB re 1 µPa rms at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies. During 2012, underwater sound from ten (10) vessels in transit, and in two instances towing or providing a tow-assist, were recorded by JASCO in the Chukchi Sea as a function of the sound source characterization (SSC) study required in the Shell 2012 Chukchi Sea drilling IHA. SSC transit and tow results from 2012 include ice management vessels, an anchor handler, OSR vessels, the OST, support tugs, and OSVs. The recorded sound pressure levels to 120 dB re 1 μPa rms for vessels in transit primarily range from ~ 0.8 – 4.3 mi (1.3 - 6.9 km), whereas the measured 120 dB re 1 μPa rms for the drilling unit *Kulluk* under tow by the *Aiviq* in the Chukchi Sea was approximately 11.8 mi (19 km) on its way to the Beaufort Sea (O'Neil and McCrodan 2012a, b). Measurements of vessel sounds from Shell's 2012 exploration drilling program in the Chukchi Sea are presented in detail in the 2012 Comprehensive Monitoring Report (LGL 2013).

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

Acoustic Impacts

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall et al. (2007) designate "functional hearing groups" for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (13 species of mysticetes): functional hearing is estimated to occur between approximately 7 Hz and 30 kHz;

- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;

- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids): functional hearing is estimated to occur between approximately 200 Hz and 180 kHz;

- Phocid pinnipeds in Water: functional hearing is estimated to occur between approximately 75 Hz and 100 kHz; and

- Otariid pinnipeds in Water: functional hearing is estimated to occur between approximately 100 Hz and 40 kHz.

As mentioned previously in this document, 12 marine mammal species under NMFS jurisdiction (eight cetaceans and four phocid pinnipeds) may occur in the proposed seismic survey area. Of the eight cetacean species likely to occur in the proposed project area and for which take is requested, five are classified as low-frequency cetaceans (i.e., bowhead, fin, minke, humpback, and gray whales), two are classified as mid-frequency cetaceans (i.e., beluga and killer whales), and one is classified as a high-frequency cetacean (i.e., harbor porpoise) (Southall et al., 2007). A species functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

Detailed description of the potential noise effects on marine mammals is provided in the *Federal Register* notice for the proposed IHA.

4.1.1.2 Effects of Vessel Activity on Marine Mammals

Reactions of marine mammals 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. Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al., 1989; Richardson et al., 1995a; Heide-Jorgensen et al., 2003). Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. In places where boat traffic is heavy, there have been cases where seals have habituated to vessel disturbance (e.g. Bonner, 1982; Jansen et al., 2006).

Collisions with vessels are possible but highly unlikely. Ship strikes of marine mammals can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus, 2001). Massive propeller wounds can be immediately fatal. If more superficial, whales may be able to survive the collisions (Silber et al., 2009). Vessel speed is a key factor in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 knots and greater (Laist et al., 2001; Vanderlaan and Taggart, 2007). Shell has agreed to travel at slower speeds. In the Beaufort Sea, Shell has agreed not to operate vessels at speeds greater than 9 knots.

Incidence of injury caused by vessel collisions appears to be low in the Arctic. Less than 1% of bowhead whales have scars indicative of vessel collision. This could be due to either collisions resulting in death (and not accounted for) or a low incidence of co-occurrence of ships and bowhead whales (George et al., 1994).

4.1.1.3 Effects of Drilling Wastes on Marine Mammals

Shell will discharge drilling wastes to the Chukchi Sea. These discharges will be authorized under the EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Oil and Gas Exploration Activities on the Outer Continental Shelf in the Chukchi Sea (AKG-28-8100; NPDES exploration facilities GP). This permit establishes various limits and conditions on the authorized discharges, and the EPA has determined that with these limits and conditions the discharges will not result in any unreasonable degradation of ocean waters.

Under the NPDES exploration facilities GP, drilling wastes to be discharged must have a 96-hr Lethal Concentration 50 percent (LC50) toxicity of 30,000 parts per million or greater at the point of discharge. Both modeling and field studies have shown that discharged drilling wastes are diluted rapidly in receiving waters (Ayers et al. 1980a, 1980b, Brandsma et al. 1980, NRC 1983, O'Reilly et al. 1989, Nedwed et al. 2004, Smith et al. 2004; Neff 2005). The dilution is strongly affected by the discharge rate. The NPDES exploration facilities GP limits the discharge of drilling wastes to 1,000 bbl/hr (159 m^3/hr). For example, TetraTech (2011) modeled hypothetical 1,000 bbl/hr (159 m^3/hr) discharges of drilling wastes in water depths of 131-164 ft (40-50 m) in the Beaufort and Chukchi Seas for the EPA and predicted dilution factors of 950-17,500 at a distance of 330 ft (100 m) from the discharge point.

The primary effect of the drilling waste discharges will be increases in total suspended solids (TSS) in the water column and localized increase in sedimentation on the sea floor. Shell conducted dispersion modeling of the drilling waste discharges using the Offshore Operators Committee Mud and Produced Water Discharge (OOC) model (Fluid Dynamix 2014). Simulations were performed for each of the six discrete drilling intervals with two discharge locations: seafloor and sea surface. The Burger Prospect wells are all very similar in well design and site conditions so the simulation approximates the results for the all drill sites. The model results indicate that most of the increase in TSS will be ameliorated within 984 ft (300 m) of the discharge locations through settling and dispersion. Impacts to water quality will cease when the discharge is concluded.

Modeling of similar discharges offshore of Sakhalin Island predicted a 1,000-fold dilution within 10 minutes and 330 ft (100 m) of the discharge. In a field study (O'Reilly et al. 1989) of a drilling waste discharge offshore of California, a 270 bbl (43 m^3) discharge of drilling wastes was found to be diluted 183-fold at 33 ft (10 m) and 1,049-fold at 330 ft (100 m). Neff (2005) concluded that concentrations of discharged drilling waste to levels that would have no effect within about two minutes of discharge and within 16 ft (5 m) of the discharge location.

Discharges of drilling wastes could potentially displace marine mammals a short distance from a drilling location. However, it is likely that marine mammals will have already avoided the area due to sound energy generated by the drilling activities.

Baleen whales, such as bowheads, tend to avoid drilling units at distances up to 12 mi (20 km). Therefore, it is highly unlikely that the whales will swim or feed in close enough proximity of discharges to be affected. The levels of drilling waste discharges are regulated by the NPDES exploration facilities GP. The impact of drilling waste discharges would be localized and temporary. Drilling waste discharges could displace endangered whales (bowhead and humpback whales) a short distance from a drill site. Effects on the whales present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, endangered whales are not likely to have long-term exposures to drilling wastes because of the episodic nature of discharges (typically only a few hours in duration).

Like other baleen whales, gray whales will more than likely avoid drilling activities and therefore not come into close contact with drilling wastes. Gray whales are benthic feeders and the seafloor area covered by accumulations of discharged drilling wastes will be unavailable to the whales for foraging purposes, and represents an indirect impact on these animals. Such indirect impacts are negligible resulting in little effect on individual whales and no effect on the population, because such areas of disturbance will be few and in total will occur over a very small area representing an extremely small portion of available foraging habitat in the Chukchi Sea. Other baleen whales such as the minke whale, which could be found near the drill site, would not be expected to be affected.

Discharges of drilling wastes are not likely to affect beluga whales and other odontocetes such as harbor porpoises and killer whales. These marine mammals will likely avoid the immediate areas where drilling wastes will be discharged. Discharge modeling performed for both the *Discoverer* and the *Polar Pioneer* based on maximum prevailing current speeds of 9.84 in/s (25 cm/s), shows that sedimentation depth of drilling wastes at greater than 0.4 in (1 cm) thickness will occur within approximately 1,641 (500 m) of the drilling unit discharge point (Fluid Dynamix, 2014b). Concentrations of TSS, a transient feature of the discharge, are modeled to be below 15 mg/L at distances approximately 3,281 ft (1,000 m) from the drilling unit discharge point. Therefore, it is highly unlikely that beluga whales will come into contact with any drilling discharge and impacts are not expected.

Seals are also not expected to be impacted by the discharges of drilling wastes. It is highly unlikely that a seal would remain within 330 ft (100 m) of the discharge source for any extended period of time but if they were to remain within 330 ft (100 m) of the discharge source for an extended period of time, it is possible that physiological effects due to toxins could impact the animal.

Fine-grained particulates and other solids in drilling wastes could cause sublethal effects to organisms in the water column. Responses observed in the laboratory following exposure to drilling mud include alteration of respiration and filtration rates and altered behavior. However, Shell will recycle and cool drilling mud to minimize the effects of drilling wastes.

4.1.1.4 Effects of Potential Oil Spill on Marine Mammals

As noted above, the specified activity involves the drilling of exploratory wells and associated activities in the Chukchi Sea during the 2015 open-water season. The impacts to marine mammals that are reasonably expected to occur will be acoustic in nature. The likelihood of a large or very large (i.e., $\geq$1,000 barrels or $\geq$150,000 barrels, respectively) oil spill occurring during Shell's proposed program has been estimated to be low. A total of 35 exploration wells have been drilled between 1982 and 2003 in the Chukchi and Beaufort seas, and there have been no blowouts. In addition, no blowouts have occurred from the approximately 98 exploration wells drilled within the Alaskan OCS (MMS, 2007a). Based on modeling conducted by Bercha (2008), the predicted frequency of an exploration well oil spill in waters similar to those in the Chukchi Sea, Alaska, is 0.000612 per well for a blowout sized between 10,000 barrels (bbl) to 149,000 bbl and 0.000354 per well for a blowout greater than 150,000 bbl.

Shell has implemented several design standards and practices to reduce the already low probability of an oil spill occurring as part of its operations. The wells proposed to be drilled in the Arctic are exploratory and will not be converted to production wells; thus, production casing will not be installed, and the well will be permanently plugged and abandoned once exploration drilling is complete. Shell has also developed and will implement the following plans and protocols: Shell's Critical Operations Curtailment Plan; IMP; Well Control Plan; and Fuel Transfer Plan. Many of these safety measures are required by the Department of the Interior's interim final rule implementing certain measures to improve the safety of oil and gas exploration and development on the Outer Continental Shelf in light of the Deepwater Horizon event (see 75 FR 63346, October 14, 2010). Operationally, Shell has committed to the following to help prevent an oil spill from occurring in the Chukchi Sea:

- Shell's Blow Out Preventer (BOP) was inspected and tested by an independent third party specialist;
- Further inspection and testing of the BOP have been performed to ensure the reliability of the BOP and that all functions will be performed as necessary, including shearing the drill pipe;
- Shell will conduct a function test of annular and ram BOPs every 7 days;
- A second set of blind/shear rams will be installed in the BOP stack;
- Full string casings will typically not be installed through high pressure zones;
- Liners will be installed and cemented, which allows for installation of a liner top packer;
- Testing of liners prior to installing a tieback string of casing back to the wellhead;
- Utilizing a two-barrier policy; and
- Testing of all casing hangers to ensure that they have two independent, validated barriers at all times.

NMFS has considered Shell's proposed action and has concluded that there is no reasonable likelihood of serious injury or mortality from the 2012 Chukchi Sea exploration drilling program. NMFS has consistently interpreted the term "potential," as used in 50 CFR 216.107(a), to only include impacts that have more than a discountable probability of occurring, that is, impacts must be reasonably expected to occur. Hence, NMFS has regularly issued IHAs in cases where it found that the potential for serious injury or mortality was "highly unlikely" (See 73 FR 40512, 40514, July 15, 2008; 73 FR 45969, 45971, August 7, 2008; 73 FR 46774, 46778, August 11, 2008; 73 FR 66106, 66109, November 6, 2008; 74 FR 55368, 55371, October 27, 2009).

Interpreting "potential" to include impacts with any probability of occurring (i.e., speculative or extremely low probability events) would nearly preclude the issuance of IHAs in every instance. For example, NMFS would be unable to issue an IHA whenever vessels were involved in the marine activity since there is always some, albeit remote, possibility that a vessel could strike and seriously injure or kill a marine mammal. This would also be inconsistent with the dual-permitting scheme Congress created and undesirable from a policy perspective, as limited agency resources would be used to issue regulations that provide no additional benefit to marine mammals beyond what was proposed for the IHA.

Despite concluding that the risk of serious injury or mortality from an oil spill in this case is extremely remote, NMFS has nonetheless evaluated the potential effects of an oil spill on marine mammals. While an oil spill is not a component of Shell's specified activity, potential impacts on marine mammals from an oil spill are discussed in more detail below and will be addressed further in the Environmental Assessment.

Potential Effects of Oil on Cetaceans

The specific effects an oil spill would have on cetaceans are not well known. While mortality is unlikely, exposure to spilled oil could lead to skin irritation, baleen fouling (which might reduce feeding efficiency), respiratory distress from inhalation of hydrocarbon vapors, consumption of some contaminated prey items, and temporary displacement from contaminated feeding areas. Geraci and St. Aubin (1990) summarize effects of oil on marine mammals, and Bratton et al. (1993) provides a synthesis of knowledge of oil effects on bowhead whales. The number of cetaceans that might be contacted by a spill would depend on the size, timing, and duration of the spill and where the oil is in relation to the animals. Whales may not avoid oil spills, and some have been observed feeding within oil slicks (Goodale et al., 1981). These topics are discussed in more detail next.

In the case of an oil spill occurring during migration periods, disturbance of the migrating cetaceans from cleanup activities may have more of an impact than the oil itself. Human activity associated with cleanup efforts could deflect whales away from the path of the oil. However, noise created from cleanup activities likely will be short term and localized. In fact, whale avoidance of clean-up activities may benefit whales by displacing them from the oil spill area.

There is no direct evidence that oil spills, including the much studied Santa Barbara Channel and Exxon Valdez spills, have caused any deaths of cetaceans (Geraci, 1990; Brownell, 1971; Harvey and Dahlheim, 1994). It is suspected that some individually identified killer whales that disappeared from Prince William Sound during the time of the Exxon Valdez spill were casualties of that spill. However, no clear cause and effect relationship between the spill and the disappearance could be established (Dahlheim and Matkin, 1994). The AT-1 pod of transient killer whales that sometimes inhabits Prince William Sound has continued to decline after the Exxon Valdez oil spill (EVOS). Matkin et al. (2008) tracked the AB resident pod and the AT-1 transient group of killer whales from 1984 to 2005. The results of their photographic surveillance indicate a much higher than usual mortality rate for both populations the year following the spill (33% for AB Pod and 41% for AT-1 Group) and lower than average rates of increase in the 16 years after the spill (annual increase of about 1.6% for AB Pod compared to an annual increase of about 3.2% for other Alaska killer whale pods). In killer whale pods, mortality rates are usually higher for non-reproductive animals and very low for reproductive animals and adolescents (Olesiuk et al., 1990, 2005; Matkin et al., 2008). No effects on humpback whales in Prince William Sound were evident after the EVOS (von Ziegesar et al., 1994). There was some temporary displacement of humpback whales out of Prince William Sound, but this could have been caused by oil contamination, boat and aircraft disturbance, displacement of food sources, or other causes.

Migrating gray whales were apparently not greatly affected by the Santa Barbara spill of 1969. There appeared to be no relationship between the spill and mortality of marine mammals. The higher than usual counts of dead marine mammals recorded after the spill represented increased survey effort and therefore cannot be conclusively linked to the spill itself (Brownell, 1971; Geraci, 1990). The conclusion was that whales were either able to detect the oil and avoid it or were unaffected by it (Geraci, 1990).

(1) Oiling of External Surfaces

Whales rely on a layer of blubber for insulation, so oil would have little if any effect on thermoregulation by whales. Effects of oiling on cetacean skin appear to be minor and of little significance to the animal's health (Geraci, 1990). Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect. They switched to gasoline and applied the sponge up to 75 minutes. This produced transient damage to epidermal cells in whales. Subtle changes were evident only at the cell level. In each case, the skin damage healed within a week. They concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. These substances normally damage skin by getting between cells and dissolving protective lipids. In cetacean skin, however, tight intercellular bridges, vital surface cells, and the extraordinary thickness of the epidermis impeded the damage. The authors could not detect a change in lipid concentration between and within cells after exposing skin from a white-sided dolphin to gasoline for 16 hours in vitro.

Bratton et al. (1993) synthesized studies on the potential effects of contaminants on bowhead whales. They concluded that no published data proved oil fouling of the skin of any free-living whales, and conclude that bowhead whales contacting fresh or weathered petroleum are unlikely to suffer harm. Although oil is unlikely to adhere to smooth skin, it may stick to rough areas on the surface (Henk and Mullan, 1997). Haldiman et al. (1985) found the epidermal layer to be as much as seven to eight times thicker than that found on most whales. They also found that little or no crude oil adhered to preserved bowhead skin that was dipped into oil up to three times, as long as a water film stayed on the skin's surface. Oil adhered in small patches to the surface and vibrissae (stiff, hairlike structures), once it made enough contact with the skin. The amount of oil sticking to the surrounding skin and epidermal depression appeared to be in proportion to the number of exposures and the roughness of the skin's surface. It can be assumed that if oil contacted the eyes, effects would be similar to those observed in ringed seals; continued exposure of the eyes to oil could cause permanent damage (St. Aubin, 1990).

(2) Ingestion

Whales could ingest oil if their food is contaminated, or oil could also be absorbed through the respiratory tract. Some of the ingested oil is voided in vomit or feces but some is absorbed and could cause toxic effects (Geraci, 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt, 1978, 1982). Oil ingestion can decrease food assimilation of prey eaten (St. Aubin, 1988). Cetaceans may swallow some oil-contaminated prey, but it likely would be only a small part of their food. It is not known if whales would leave a feeding area where prey was abundant following a spill. Some zooplankton eaten by bowheads and gray whales consume oil particles and bioaccumulation can result. Tissue studies by Geraci and St. Aubin (1990) revealed low levels of naphthalene in the livers and blubber of baleen whales. This result suggests that prey have low concentrations in their tissues, or that baleen whales may be able to metabolize and excrete certain petroleum hydrocarbons. Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin, 1980, 1982) and this kind of damage has not been reported (Geraci, 1990).

(3) Fouling of Baleen

Baleen itself is not damaged by exposure to oil and is resistant to effects of oil (St. Aubin et al., 1984). Crude oil could coat the baleen and reduce filtration efficiency; however, effects may be temporary (Braithwaite, 1983; St. Aubin et al., 1984). If baleen is coated in oil for long periods, it could cause the animal to be unable to feed, which could lead to malnutrition or even death. Most of the oil that would coat the baleen is removed after 30 min, and less than 5% would remain after 24 hr (Bratton et al., 1993). Effects of oiling of the baleen on feeding efficiency appear to be minor (Geraci, 1990). However, a study conducted by Lambertsen et al. (2005) concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures in arctic waters and whether baleen function would be restored after oiling.

(4) Avoidance

Some cetaceans can detect oil and sometimes avoid it, but others enter and swim through slicks without apparent effects (Geraci, 1990; Harvey and Dahlheim, 1994). Bottlenose dolphins in the Gulf of Mexico apparently could detect and avoid slicks and mousse but did not avoid light sheens on the surface (Smultea and Wursig, 1995). After the Regal Sword spill in 1979, various species of baleen and toothed whales were observed swimming and feeding in areas containing spilled oil southeast of Cape Cod, MA (Goodale et al., 1981). For months following EVOS, there were numerous observations of gray whales, harbor porpoises, Dall’s porpoises, and killer whales swimming through light-to-heavy crude-oil sheens (Harvey and Dalheim, 1994, cited in Matkin et al., 2008). However, if some of the animals avoid the area because of the oil, then the effects of the oiling would be less severe on those individuals.

(5) Factors Affecting the Severity of Effects

Effects of oil on cetaceans in open water are likely to be minimal, but there could be effects on cetaceans where both the oil and the whales are at least partly confined in leads or at ice edges (Geraci, 1990). In spring, bowhead and beluga whales migrate through leads in the ice. At this time, the migration can be concentrated in narrow corridors defined by the leads, thereby creating a greater risk to animals caught in the spring lead system should oil enter the leads. This situation would only occur if there were an oil spill late in the season and Shell could not complete cleanup efforts prior to ice covering the area. The oil would likely then be trapped in the ice until it began to thaw in the spring.

In fall, the migration route of bowheads can be close to shore (Blackwell et al., 2009c). If fall migrants were moving through leads in the pack ice or were concentrated in nearshore waters, some bowhead whales might not be able to avoid oil slicks and could be subject to prolonged contamination. However, the autumn migration through the Chukchi Sea extends over several weeks, and some of the whales travel along routes north or inland of the area, thereby reducing the number of whales that could approach patches of spilled oil. Additionally, vessel activity associated with spill cleanup efforts may deflect whales traveling near the Burger prospect in the Chukchi Sea, thereby reducing the likelihood of contact with spilled oil.

Bowhead and beluga whales overwinter in the Bering Sea (mainly from November to March). In the summer, the majority of the bowhead whales are found in the Canadian Beaufort Sea, although some have recently been observed in the U.S. Beaufort and Chukchi Seas during the summer months (June to August). Data from the Barrow-based boat surveys in 2009 (George and Sheffield, 2009) showed that bowheads were observed almost continuously in the waters near Barrow, including feeding groups in the Chukchi Sea at the beginning of July. The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al., 1984; Ljungblad et al., 1984; Richardson et al., 1995a). Therefore, a spill in summer would not be expected to have major impacts on these species. Additionally, humpback and fin whales are only sighted in the Chukchi Sea in small numbers in the summer, as this is thought to be the extreme northern edge of their range. Therefore, impacts to these species from an oil spill would be extremely limited.

Potential Effects of Oil on Pinnipeds

Ice seals are present in open-water areas during summer and early autumn. Externally oiled phocid seals often survive and become clean, but heavily oiled seal pups and adults may die, depending on the extent of oiling and characteristics of the oil. Prolonged exposure could occur if fuel or crude oil was spilled in or reached nearshore waters, was spilled in a lead used by seals, or was spilled under the ice when seals have limited mobility (NMFS, 2000). Adult seals may suffer some temporary adverse effects, such as eye and skin irritation, with possible infection (MMS, 1996). Such effects may increase stress, which could contribute to the death of some individuals. Ringed seals may ingest oil-contaminated foods, but there is little evidence that oiled seals will ingest enough oil to cause lethal internal effects. There is a likelihood that newborn seal pups, if contacted by oil, would die from oiling through loss of insulation and resulting hypothermia. These potential effects are addressed in more detail in subsequent paragraphs.

Reports of the effects of oil spills have shown that some mortality of seals may have occurred as a result of oil fouling; however, large scale mortality had not been observed prior to the EVOS (St. Aubin, 1990). Effects of oil on marine mammals were not well studied at most spills because of lack of baseline data and/or the brevity of the post-spill surveys. The largest documented impact of a spill, prior to EVOS, was on young seals in January in the Gulf of St. Lawrence (St. Aubin, 1990). Brownell and Le Boeuf (1971) found no marked effects of oil from the Santa Barbara oil spill on California sea lions or on the mortality rates of newborn pups.

Intensive and long-term studies were conducted after the EVOS in Alaska. There may have been a long-term decline of 36% in numbers of molting harbor seals at oiled haul-out sites in Prince William Sound following EVOS (Frost et al., 1994a). However, in a reanalysis of those data and additional years of surveys, along with an examination of assumptions and biases associated with the original data, Hoover-Miller et al. (2001) concluded that the EVOS effect had been overestimated. The decline in attendance at some oiled sites was more likely a continuation of the general decline in harbor seal abundance in Prince William Sound documented since 1984 (Frost et al., 1999) rather than a result of EVOS. The results from Hoover-Miller et al. (2001) indicate that the effects of EVOS were largely indistinguishable from natural decline by 1992. However, while Frost et al. (2004) concluded that there was no evidence that seals were displaced from oiled sites, they did find that aerial counts indicated 26% fewer pups were produced at oiled locations in 1989 than would have been expected without the oil spill. Harbor seal pup mortality at oiled beaches was 23% to 26%, which may have been higher than natural mortality, although no baseline data for pup mortality existed prior to EVOS (Frost et al., 1994a). There was no conclusive evidence of spill effects on Steller sea lions (Calkins et al., 1994). Oil did not persist on sea lions themselves (as it did on harbor seals), nor did it persist on sea lion haul-out sites and rookeries (Calkins et al., 1994). Sea lion rookeries and haul out sites, unlike those used by harbor seals, have steep sides and are subject to high wave energy (Calkins et al., 1994).

(1) Oiling of External Surfaces

Adult seals rely on a layer of blubber for insulation, and oiling of the external surface does not appear to have adverse thermoregulatory effects (Kooyman et al., 1976, 1977; St. Aubin, 1990). Contact with oil on the external surfaces can potentially cause increased stress and irritation of the eyes of ringed seals (Geraci and Smith, 1976; St. Aubin, 1990). These effects seemed to be temporary and reversible, but continued exposure of eyes to oil could cause permanent damage (St. Aubin, 1990). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976) and in seals in the Antarctic after an oil spill (Lillie, 1954).

Newborn seal pups rely on their fur for insulation. Newborn ringed seal pups in lairs on the ice could be contaminated through contact with oiled mothers. There is the potential that newborn ringed seal pups that were contaminated with oil could die from hypothermia.

(2) Ingestion

Marine mammals can ingest oil if their food is contaminated. Oil can also be absorbed through the respiratory tract (Geraci and Smith, 1976; Engelhardt et al., 1977). Some of the ingested oil is voided in vomit or feces but some is absorbed and could cause toxic effects (Engelhardt, 1981). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt, 1978, 1982, 1985). In addition, seals exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin, 1980, 1982).

(3) Avoidance and Behavioral Effects

Although seals may have the capability to detect and avoid oil, they apparently do so only to a limited extent (St. Aubin, 1990). Seals may abandon the area of an oil spill because of human disturbance associated with cleanup efforts, but they are most likely to remain in the area of the spill. One notable behavioral reaction to oiling is that oiled seals are reluctant to enter the water, even when intense cleanup activities are conducted nearby (St. Aubin, 1990; Frost et al., 1994b, 2004).

(4) Factors Affecting the Severity of Effects

Seals that are under natural stress, such as lack of food or a heavy infestation by parasites, could potentially die because of the additional stress of oiling (Geraci and Smith, 1976; St. Aubin, 1990; Spraker et al., 1994). Female seals that are nursing young would be under natural stress, as would molting seals. In both cases, the seals would have reduced food stores and may be less

resistant to effects of oil than seals that are not under some type of natural stress. Seals that are not under natural stress (e.g., fasting, molting) would be more likely to survive oiling.
In general, seals do not exhibit large behavioral or physiological reactions to limited surface oiling or incidental exposure to contaminated food or vapors (St. Aubin, 1990; Williams et al., 1994). Effects could be severe if seals surface in heavy oil slicks in leads or if oil accumulates near haul-out sites (St. Aubin, 1990). An oil spill in open-water is less likely to impact seals.

The potential effects to marine mammals described in this section of the document do not take into consideration the proposed monitoring and mitigation measures described later in this document (see the "Proposed Mitigation" and "Proposed Monitoring and Reporting" sections).

4.1.1.5 Conclusion of Effects on Marine Mammals

In summary, the most likely impacts of the potential action could be behavioral disturbance reactions from the introduction of noise into the marine environment (drill ship, ZVSP airguns) and vessel and aircraft activity. There is also a potential for some acoustic masking in baleen whales, as the frequencies of their hearing and vocalizations overlap with the frequencies of much of the equipment to be used during the exploration drilling operations. It is less likely that masking would occur in odonotocetes and pinnipeds because of the higher frequencies of their hearing and vocalizations. Impacts from drill cuttings, drilling muds, and other discharges are likely to be minor, if they occur at all. Additionally, impacts from small fuel spills are anticipated to be minor.

Overall, impacts to marine mammals are anticipated to have minor to moderate effects. Impacts would only occur during the time that the animals are in the ensonified areas and are expected to be short-term in duration and limited to behavioral disturbance. Please refer to the Federal Register notice for the proposed IHA for a more in depth discussion on the potential effects on marine mammals from Shell's proposed exploration drilling activities.

4.1.2 Effects on Marine Mammal Habitat

The primary potential impacts to marine mammals and other marine species are associated with elevated sound levels produced by the exploratory drilling program (i.e. the drillship and the airguns). However, other potential impacts are also possible to the surrounding habitat from physical disturbance and an oil spill (should one occur). This section describes the potential impacts to marine mammal habitat from the specified activity. Because the marine mammals in the area feed on fish and/or invertebrates there is also information on the species typically preyed upon by the marine mammals in the area.

4.1.2.1 Effects on Habitat from Seafloor Disturbance (Mooring and MLC Construction)

Mooring of the drilling units and construction of MLCs will result in some seafloor disturbance and temporary increases in water column turbidity.

The drilling units would be held in place during operations with systems of eight anchors for each unit. The embedment type anchors designed to embed into the seafloor thereby providing the required resistance. The anchors will penetrate the seafloor on contact and may drag 2-3 or more times their length while being set. Both the anchor and anchor chain will disturb sediments in this process creating a trench or depression with surrounding berms where the displaced sediment is mounded. Some sediments will be suspended in the water column during the setting and subsequent removal of the anchors. The depression with associated berm, collectively known as an anchor scar, remains when the anchor is removed.

Dimensions of future anchor scars can be estimated based on the dimensions of the anchor. Shell estimates that each anchor may impact a seafloor area of up to about 2,510 ft^2 ($233m^2$). Minimum impact estimates associated with mooring the *Discoverer* at a well by its eight anchors is 18,267 ft^2 (1,697 m^2) of seafloor assuming that the anchors are set only once and 20,078 ft^2 (1,865 m^2) for the *Polar Pioneer*. Shell plans to pre-set anchors and deploy mooring lines at each drill site prior to arrival of the drilling units. Unless moved by an outside force such as sea current, anchors should only need to be set once per drill site.

Once the drilling units end operation, the *Polar Pioneer* anchors will be retrieved and the *Discoverer* anchors may be left on site for wet storage. Over time the anchor scars will be filled through natural movement of sediment. The duration of the scars depends upon the energy of the system, water depth, ice scour, and sediment type. Anchor scars were visible under low energy conditions in the North Sea for five to ten years after retrieval. Scars typically do not form or persist in sandy mud or sand sediments but may last for nine years in hard clays (Centaur Associates, Inc 1984). Surficial sediments in Shell's Burger Prospect consist of soft sandy mud (silt and clay) with lesser amounts of gravel (Battelle Memorial Institute 2010; Blanchard et al. 2010a, b). The energy regime, plus possible effects of ice gouge in the Chukchi Sea suggests that anchor scars would be refilled faster than in the North Sea.

Excavation of each MLC by the drilling units using a large diameter drill bit will displace about $589m^3$ of seafloor sediments and directly disturb approximately 1,075 ft^2 (100 m^2) of seafloor. Pressurized air and seawater (no drilling mud used) will be used to assist in the removal of the excavated materials from the MLC. Some of the excavated sediments will be displaced to adjacent seafloor areas and some will be pumped and discharged on the seafloor away from the MLC. These excavated materials will also have some indirect effects as they are suspended in the water and deposited on the seafloor in the vicinity of the MLCs. Direct and indirect effects would include slight changes in seafloor relief and sediment consistency, and smothering of benthic organisms.

4.1.2.2 Effects on Habitat from Sound Generation

Underwater noise generated from Shell’s proposed exploration drilling activity may potentially affect marine mammal prey species, which are fish species and various invertebrates in the action area.

(1) Zooplankton

Zooplankton are food sources for several endangered species, including bowhead, fin, and humpback whales. The primary generators of sound energy associated with the exploration drilling program are the airgun array during the conduct of ZVSPs, the drilling units during drilling, and marine vessels, particularly during ice management and DP. Sound energy generated by these activities will not negatively impact the diversity and abundance of zooplankton, and will therefore have no direct effect on marine mammals.

Sound energy generated by the airgun arrays to be used for the ZVSPs will have no more than negligible effects on zooplankton. Studies on euphausiids and copepods, which are some of the more abundant and biologically important groups of zooplankton in the Chukchi Sea, have documented the use of hearing receptors to maintain schooling structures (Wiese 1996) and detection of predators respectively, and therefore have some sensitivity to sound; however any effects of airguns on zooplankton would be expected to be restricted to the area within a few feet or meters of the airgun array and would likely be sublethal. Studies on brown shrimp in the Wadden Sea (Webb and Kempf 1998) revealed no particular sensitivity to sounds generated by airguns used in with sound levels of 190 dB re 1 μPa rms at 3.3 ft. (1.0 m) in water depths of 6.6 ft. (2.0 m). A recent Canadian government review of the impacts of seismic sound on invertebrates and other organisms (CDFO 2004) included similar findings; this review noted "there are no documented cases of invertebrate mortality upon exposure to seismic sound under field operating conditions" (CDFO 2004). Some sublethal effects (e.g., reduced growth, behavioral changes) were noted (CDFO 2004).

The energy from airguns has sometimes been shown to damage eggs and fry of some fish. Eggs and larvae of some fish may apparently sustain sublethal to lethal effects if they are within very close proximity to the seismic-energy-discharge point. These types of effects have been demonstrated by some laboratory experiments using single airguns, while other similar studies have found no material increases in mortality or morbidity due to airgun exposure. The effects, where they do occur, are apparently limited to the area within 3-6 ft. (1-2 m) from the airgun-discharge ports. Most investigators and reviewers have concluded that even seismic surveys with much larger airgun arrays than are used for shallow hazards and site clearance surveys, have no impact to fish eggs and larvae discernible at the population or fisheries level.

These studies indicate that some zooplankton within a distance of about 16 ft. (5.0 m) or less from the airgun array may sustain sublethal or lethal injuries but there would be no population effects even over small areas. Therefore there would be no indirect effect on marine mammals.

Ice management vessels are likely to be the most intense sources of sound associated with the exploration drilling program Richardson et al. (1995a). Ice management vessels, during active ice management, may have to adjust course forward and astern while moving ice and thereby create greater variability in propeller cavitation than other vessels that maintain course with less adjustment. The drilling units maintain station during drilling without activation of propulsion propellers. Richardson (et al.1995a) reported that the noise generated by an icebreaker pushing ice was 10-15 dB re 1 μPa rms greater than the noise produced by the ship underway in open water. It is expected that the lower level of sound produced by the drilling units, ice management, or other vessels would have less impact on zooplankton than would 3D seismic (survey) sound.

No appreciable adverse impact on zooplankton populations will occur due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortality or impacts on zooplankton as a result of Shell's operations is immaterial as compared to the naturally occurring reproductive and mortality rates of these species. This is consistent with previous conclusions that crustaceans (such as zooplankton) are not particularly sensitive to sound produced by seismic sounds (Wiese 1996). Impact from sound energy generated by an ice breaker, other marine vessels, and drill ships would have less impact, as these activities produce lower sound energy levels (Burns 1993). Historical sound propagation studies performed on the *Kulluk* by Hall et al. (1994) also indicate the *Kulluk* and similar drilling units would have lower sound energy output than three-dimensional seismic sound sources (Burns et al. 1993). The drilling units *Discoverer* and *Polar Pioneer* would emit sounds at a lower level than the *Kulluk* and therefore the impacts due to drilling noise would be even lower than the *Kulluk*. Therefore, zooplankton organisms would not likely be affected by sound energy levels by the vessels to be used during Shell's exploration drilling activities in the Chukchi Sea.

(2) Benthos

There was no indication from benthic biomass or density that previous drilling activities at the Hammerhead Prospect have had a measurable impact on the ecology of the immediate local area. To the contrary, the abundance of benthic communities in the Sivulliq area would suggest that the benthos were actually thriving there (Dunton et al. 2008).

Sound energy generated by exploration drilling and ice management activities will not appreciably affect diversity and abundance of plants or animals on the seafloor. The primary generators of sound energy are the drilling units and marine vessels. Ice management vessels are likely to be the loudest sources of sounds associated with the exploration drilling program (Richardson et al. 1995a). Ice management vessels, during active ice management, may have to adjust course forward and astern while moving ice and thereby create greater variability in propeller cavitation than other vessels that maintain course with less adjustment. The drilling units maintain station during drilling without activation of propulsion propellers. Richardson et al. (1995a) reported that the noise generated by an icebreaker pushing ice was 10-15 dB re 1 μPa rms greater than the noise produced by the ship underway in open water. The lower level of sound produced by the drilling units, ice management vessels, or other vessels will have less impact on bottom-dwelling organisms than would 3D seismic (survey) sound.

No appreciable adverse impacts on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortalities or impacts that might occur as a result of Shell's operations is immaterial compared to the naturally occurring high reproductive and mortality rates. This is consistent with previous BOEM conclusions that the effect of seismic exploration on benthic organisms probably would be immeasurable (USDI/MMS 2007). Impacts from sound energy generated by ice breakers, other marine vessels, and drilling units would have less impact, as these activities produce much lower sound energy levels (Burns et al. 1993).

(3) Fish

Fish react to sound and use sound to communicate (Tavolga et al. 1981). Experiments have shown that fish can sense both the intensity and direction of sound (Hawkins 1981). Whether or not fish can hear a particular sound depends upon its frequency and intensity. Wavelength and the natural background sound also play a role. The intensity of sound in water decreases with distance as a result of geometrical spreading and absorption. Therefore, the distance between the sound source and the fish is important. Physical conditions in the sea, such as temperature thermoclines and seabed topography, can influence transmission loss and thus the distance at which a sound can be heard.

The impact of sound energy from exploration drilling and ice management activities will be negligible and temporary. Fish typically move away from sound energy above a level that is at 120 dB re 1 μPa rms or higher (Ona 1988).

Drilling unit sound source levels during drilling can range from 90 dB re 1 μPa rms within 31 mi (50 km) of the drilling unit to 138 dB re 1 μPa rms within a distance of 0.06 mi (0.01 km) from the drilling unit (Greene 1985, 1987b). These are predicted sound levels at various distances based on modeled transmission loss equations in the literature (Greene 1987b). Ice management vessel sound source levels can range from 174-184 dB re 1 μPa rms. At these intensity levels, fish may avoid the drilling unit, ice management vessels, or other large support vessels. This avoidance behavior is temporary and limited to periods when a vessel is underway or drilling. There have been no studies of the direct effects of ice management vessel sounds on fish. However, it is known that the ice management vessels produce sounds generally 10-15 dB re 1 μPa rms higher when moving through ice rather than open water (Richardson et al. 1995b). In general, fish show greater reactions to a spike in sound energy levels, or impulse sounds, rather than a continuous high intensity signal (Blaxter et al. 1981).

Fish sensitivity to impulse sound such as that generated by ZVSPs varies depending on the species of fish. Cod, herring and other species of fish with swim bladders have been found to be relatively sensitive to sound, while mackerel, flatfish, and many other species that lack swim bladders have been found to have poor hearing (Hawkins 1981, Hastings and Popper 2005). An alarm response in these fish is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level (Blaxter et al. 1981). Any such effects on fish would be negligible and have no indirect effect on marine mammals.

4.1.2.3 Effects on Habitat from Drilling Units' Presence

The length of the *Discoverer* at 514 ft (156.7 m) and *Polar Pioneer* at 279 ft (85m) are not large enough to cause large-scale diversions from the animals' normal swim and migratory paths. The drilling units' physical footprints are small relative to the size of the geographic region either would occupy, and will likely not cause marine mammals to deflect greatly from their typical migratory routes.

Any deflection of bowhead whales or other marine mammal species due to the physical presence of the drilling units or support vessels would be extremely small. Even if animals may deflect because of the presence of the drilling units, the Chukchi Sea's migratory corridor is much larger in size than the length of the drilling units, and animals would have other means of passage around the drilling units. In sum, the physical presence of the drilling units is not likely to cause a material deflection to migrating marine mammals.

Seal species which may be encountered during ice management activities include ringed seals, bearded seals, spotted seals, and the much less common ribbon seal. Ringed seals are found in the activity area year-around. Bearded seals spend the winter season in the Bering Sea, and then follow the ice edge as it retreats in spring. Spotted seals are found in the Bering Sea in winter and spring where they breed, molt, and pup in large groups. Few spotted seals are expected to be encountered in the Chukchi Sea until July. Even then, they are rarely seen on pack ice but are commonly observed hauled out on land or swimming in open water.

Based on extensive analysis of digital imagery taken during aerial surveys in support of Shell's 2012 operations in the Chukchi and Beaufort Seas, ice seals are very infrequently observed hauled out on the ice in groups of greater than one individual. Tens of thousands of images from 17 flights that took place from July through October were reviewed in detail. Of 107 total observations of spotted or ringed seals on ice, only three of those sightings were of a group of two or more individuals. Since seals are found as individuals or in very small groups when they are in the activity area, the chance of a stampede event is very unlikely. Finally, ice seals are well adapted to move between ice and water without injury, including "escape reactions" to avoid predators.

4.1.2.4 Effects on Habitat from Drilling Wastes

Discharges of drilling wastes must be authorized by the NPDES exploration facilities GP, and this GP places numerous conditions and limitations on such discharges. The EPA (2012) has determined that with these limits and conditions in place, the discharges will not result in any unreasonable degradation of ocean waters. The primary impacts of the discharges are increases in TSS in the water column and the deposition of drilling wastes on the seafloor. These impacts would be localized to the drill sites and temporary.

(1) Zooplankton

Reviews by EPA (2006) and Neff (2005) indicate that though planktonic organisms are sensitive to environmental conditions (e.g., temperature, light, availability of nutrients, and water quality), there is little or no evidence of effects from drilling waste discharges on plankton in the ocean. In the laboratory, high concentrations of drilling wastes have been shown to have lethal or sublethal effects on zooplankton due to toxicity and abrasion by suspended sediments. These effects are minimized at the drill site by limits and conditions placed on the discharges by the NPDES exploration facilities GP, which include discharge rate limits and toxicity limits.

Any impact by drilling waste discharges on zooplankton would be localized and temporary. Fine-grained particulates and other solids in drilling wastes could cause sublethal effects to organisms in the water column. Responses observed in the laboratory following exposure to drilling mud include alteration of respiration and filtration rates and altered behavior. Zooplankton in the immediate area of discharge from drilling operations could potentially be adversely impacted by sediments in the water column, which could clog respiratory and feeding structures, cause abrasions to gills and other sensitive tissues, or alter behavior or development. However, the planktonic organisms are not likely to have long-term exposures to the drilling waste because of the episodic nature of discharges (typically only a few hours in duration), the small area affected, and the movement of the organisms with the ocean currents. The discharged waste must have low toxicities to meet permit requirements and modeling studies indicate dilution factors of >1,000 within 328 ft (100 m). Modeling and monitoring studies have demonstrated that increased TSS in the water column from the discharges would largely be limited to the area within 984 ft (300 m) from the discharge. This impact would likely not have more than a short-term impact on zooplankton and no effect on zooplankton populations, and therefore no indirect effects on marine mammals.

(2) Benthos

Benthic organisms would primarily be affected by the discharges through the deposition of the discharged drilling waste on the seafloor resulting in the smothering of organisms, changes in the consistency of sediments on the seafloor, and possible elevation in heavy metal concentrations in the accumulations.

Drilling waste discharges are regulated by the EPA's NPDES exploration facilities GP. The impact of drilling waste discharges would be localized and temporary. Effects on benthic organisms present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, benthic animals are not likely to have long-term exposures to drilling wastes because of the episodic nature of discharges (typically only a few hours in duration).

Shell conducted dispersion modeling of the drilling waste discharges using the Offshore operators Committee Mud and Produced Water Discharge (OOC) model (Fluid Dynamix 2014). The modeling effort provided predictions of the area and thickness of accumulations of discharged drilling waste on the seafloor. The USA EPA has performed an evaluation of drilling waste in support of the issuance of NPDES exploration facilities GP AKG-28-8100 (ODCE for Chukchi Exploration NPDES General Permit ES-3 Final (October 2012), and determined these accumulation will not result in any unreasonable degradation of the marine environment.

Heavy metal contamination of sediments and resulting effects on benthic organisms is not expected. The NPDES exploration facilities GP contains stringent limitations on the concentrations of mercury, cadmium, chromium, silver, and thallium allowed in discharged drilling waste. Additional limitations are placed on free oil, diesel oil, and total aromatic hydrocarbons allowed in discharged drilling waste. Discharge rates are also controlled by the permit. Baseline studies at the 1985 Hammerhead drill site (Trefry and Trocine 2009) detected background levels Al, Fe, Zn, Cd and Hg in all surface and subsurface sediment samples. Considering the relatively small area that drilling waste discharges will be deposited, no material impacts on sediment are expected to occur. The expected increased concentrations of Zn, Cd, and Cr in sediments near the drill site due to the discharge are in the range where no or low effects would result.

Studies in the 1980s, 1999, 2000, and 2002 (Brown et al. 2001 in USDI/MMS 2003) also found that benthic organism near drill sites in the Beaufort Sea have accumulated neither petroleum hydrocarbon nor heavy metals. In 2008 Shell investigated the benthic communities (Dunton et al. 2008) and sediments (Trefry and Trocine 2009) around the Sivulliq Prospect including the location of the historical Hammerhead drill site that was drilled in 1985. Benthic communities at the historical Hammerhead drill site were found not to differ statistically in abundance, community structure, or diversity, from benthic communities elsewhere in this portion of the Beaufort Sea, indicating that there was no long term effect.

Sediment samples taken in the CSESP Burger Study Area were analyzed for metal and hydrocarbon concentrations (Neff et al. 2010). Concentrations of all measured hydrocarbon types were found to be well within the range of non-toxic background concentrations reported by other Alaskan and Arctic coastal and shelf sediment studies (Neff et al. 2010, Dunton et al. 2012). Metal concentrations were found to be quite variable. Average concentrations of all metals except for arsenic and barium were found to be lower than those reported for average marine sediment.

Trefry et al. (2012) confirmed findings by Neff et al. 2010 that concentrations of all measured hydrocarbon types were well within the range of non-toxic background concentrations reported by other Alaskan and Arctic coastal and shelf sediment studies.

Neff et al. (2010) assessed the concentrations of metals and various hydrocarbons in sediments at the historic Burger and Klondike wells in the Chukchi Sea, which were drilled in 1989-1990. Surface and subsurface sediments collected in 2008 at the historic drill sites contained higher concentrations of all types of analyzed hydrocarbon in comparison to the surrounding area. The same pattern was found for the metal barium, with concentrations 2-3 times greater at the historic drill sites (mean = 1,410 μ/g and 1,300 μ/g) than in the surrounding areas (639 μ/g and 595 μ/g). Concentrations of copper, mercury, and lead, were elevated in a few samples from the historic drill sites where barium was also elevated. All observed concentrations of hydrocarbons or metals in the sediment samples from the historic drill sites were below levels (below ERL or Effects Range Low of Long 1995) believed to have adverse ecological effects (Neff et al. 2010). Similar results were reported by Trefry and Trocine (2009) for the historic Hammerhead drill sites in the Beaufort Sea.

These data show that the potential accumulation of heavy metals in discharged drilling waste on the Chukchi seafloor associated with drilling exploration wells is very limited and does not pose a threat. Impacts to seafloor sediments from the discharge of drilling wastes will be minor, as they would be restricted to a very small portion of the activity area and will not result in contamination.

The drilling waste discharges will be conducted as authorized by the EPA's NPDES exploration facilities GP, which limits the metal content and flow rate for such discharges. The EPA (2012b) analyzed the effects of these types of discharges, including potential transport of pollutants such as metals by biological, physical, or chemical processes, and has concluded that these types of discharges do not result in unreasonable degradation of ocean waters. The physical effects of mooring and MLC construction would be restricted to a very small portion of the Chukchi Sea seafloor (15.7-33.2 ac in total for the exploration program) which represents less than 0.000011% - 0.000024% of the seafloor of the Chukchi Sea. However, the predicted small increases in concentrations of metals will likely be evident for a number of years until gouged by ice, redistributed by currents, or buried under natural sedimentation.

There is relatively little information on the effects of various deposition depths on arctic biota (Hurley and Ellis 2004); most such studies have investigated the effects of deposition of dredged materials (Wilbur 1992). Burial depths as low as 1.0 in (2.54 cm) have been found to be lethal for some benthic organisms (Wilbur 1992, EPA 2006). Accumulations of drilling waste to depths > 1.0 in (>2.54 cm) will be restricted to very small areas of the seafloor around each drill site and in total represent an extremely small portion of the Chukchi Sea. These areas would be re-colonized by benthic organisms rather quickly. Impacts to benthic organisms are therefore considered to be negligible with no indirect effects on marine mammals. As required by the NPDES exploration facilities GP, Shell will implement an environmental monitoring program (EMP), to assess the recovery of the benthos from impacts drilling waste discharges.

(3) Fish

Drilling waste discharges are regulated by the NPDES exploration facilities GP. The impact of drilling waste discharges would be localized and temporary. Drilling waste discharges could displace fish a short distance from a drill site. Effects on fish and fish larvae present within a few meters of the discharge point would be expected, primarily due to sedimentation. However, fish and fish larvae that live in the water column are not likely to have long-term exposures to drilling wastes because of the episodic nature of the discharges (typically only a few hours in duration).

Although unlikely at deeper offshore drilling locations, demersal fish eggs could be smothered if discharges occur in a spawning area during the period of egg production. No specific demersal fish spawning locations have been identified at the Burger drill site locations. The most abundant and trophically important marine fish, the Arctic cod, spawns with planktonic eggs and larvae under the sea ice during winter and will therefore have little exposure to discharges.

Habitat alteration concerns apply to special or relatively uncommon habitats, such as those important for spawning, nursery, or overwintering. Important fish overwintering habitats are located in coastal rivers and nearshore coastal waters, but are not found in the proposed exploration drilling areas. Important spawning areas have not been identified in the Chukchi Sea. Impacts on fish will be negligible, with no indirect effects on marine mammals.

4.1.2.5 Effects on Habitat from Ice Management/Icebreaking Activities

Ice management or icebreaking activities include the physical pushing or moving of ice in the proposed exploration drilling area and to prevent ice floes from striking the drilling unit. Ringed, bearded, and spotted seals (along with the ribbon seal and walrus) are dependent on sea ice for at least part of their life history. Sea ice is important for life functions such as resting, breeding, and molting. These species are dependent on two different types of ice: pack ice and landfast ice. Shell does not expect to have to manage pack ice during the majority of the drilling season. The majority of the ice management or icebreaking should occur in the early and latter portions of the drilling season. Landfast ice would not be present during Shell's proposed operations.

The ringed seal is the most common pinniped species in the Chukchi Sea activity area. While ringed seals use ice year-round, they do not construct lairs for pupping until late winter/early spring on the landfast ice. Shell plans to conclude drilling on or before 31 October, therefore Shell's activities would not impact ringed seal lairs or habitat needed for breeding and pupping in the Chukchi Sea. Ringed seals can be found on the pack ice surface in the late spring and early summer in the Chukchi Sea, the latter part of which may overlap with the start of Shell's planned exploration drilling activities. Management of pack ice that contains hauled out seals may result in the animals becoming startled and entering the water, but such effects would be brief.

Ice management would or icebreaking occur during a time when ringed seal life functions such as breeding, pupping, and molting do not occur in the proposed project area. Additionally, these life functions occur more commonly on landfast ice, which will not be impacted by Shell's activity.

Bearded seals breed in the Bering and Chukchi Seas, but would not be plentiful in the area of the Chukchi Sea exploration drilling program. Spotted seals are even less common in the Chukchi Sea activity area. Ice is used by bearded and spotted seals for critical life functions such as breeding and molting, but it is unlikely these life functions would occur in the proposed project area, during the time in which drilling activities will take place. The availability of ice would not be impacted as a result of Shell's exploration drilling program.

Ice-management or icebreaking related to Shell's planned exploration drilling program in the Chukchi Sea is not expected to have any habitat-related effects that could cause material or long-term consequences for individual marine mammals or on the food sources that they utilize.

4.1.2.6 Effects on Habitat from Oil Spill

Lower trophic organisms and fish species are primary food sources for Arctic marine mammals. However, as noted earlier in this document, the offshore areas of the Chukchi Sea are not primary feeding grounds for many of the marine mammals that may pass through the area. Therefore, impacts to lower trophic organisms (such as zooplankton) and marine fishes from an oil spill in the proposed drilling area would not be likely to have long-term or significant consequences to marine mammal prey. Impacts would be greater if the oil moves closer to shore, as many of the marine mammals in the area have been seen feeding at nearshore sites (such as bowhead whales). Gray whales do feed in more offshore locations in the Chukchi Sea; therefore, impacts to their prey from oil could have some impacts.

Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations is expected to occur soon after the surface oil passes. Spill response activities are not likely to disturb the prey items of whales or seals sufficiently to cause more than minor effects. Spill response activities could cause marine mammals to avoid the disturbed habitat that is being cleaned. However, by causing avoidance, animals would avoid impacts from the oil itself. Additionally, the likelihood of an oil spill is expected to be very low, as discussed earlier in this document.

4.1.3 Effects on Subsistence

4.1.3.1 Subsistence Activities in the Action Area

NMFS has defined "unmitigable adverse impact" in 50 CFR 216.103 as "an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

Noise and general activity during Shell's proposed drilling program have the potential to impact marine mammals hunted by Native Alaskans. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously in this document) is avoidance of the ensonified area. In the case of bowhead whales, this often means that the animals divert from their normal migratory path by several kilometers. Helicopter activity also has the potential to disturb cetaceans and pinnipeds by causing them to vacate the area. Additionally, general vessel presence in the vicinity of traditional hunting areas could negatively impact a hunt. Native knowledge indicates that bowhead whales become increasingly "skittish" in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing (which makes harvesting more difficult). Additionally, natives report that bowheads exhibit angry behaviors in the presence of seismic activity, such as tail-slapping, which translate to danger for nearby subsistence harvesters.

Plan of Cooperation or Measures to Minimize Impacts to Subsistence Hunts

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

Shell has prepared and will implement a POC pursuant to BOEM Lease Sale Stipulation No. 5, which requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and the subsistence activities and resources of residents of the North Slope. This stipulation also requires adherence to USFWS and NMFS regulations, which require an operator to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 CFR § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). A POC was prepared and submitted with the initial Chukchi Sea EP that was submitted to BOEM in May 2009, and approved on 7 December 2009. Subsequent POC Addendums were submitted in May 2011 with a revised Chukchi Sea EP and the IHA application for the 2012 exploration drilling program. For this IHA application, Shell has again updated the POC Addendum to include documentation of meetings undertaken to specifically gather feedback from stakeholder communities on Shell's implementation of the Chukchi Sea exploration drilling program during 2012, plus inform and obtain their input regarding the continuation of the program with the addition of a second drilling unit, additional vessels and aircraft.

The POC Addendum identifies the measures that Shell has developed in consultation with North Slope subsistence communities to minimize any adverse effects on the availability of marine mammals for subsistence uses and will implement during its planned Chukchi Sea exploration drilling program planned to continue in the summer of 2015. In addition, the POC Addendum details Shell's communications and consultations with local subsistence communities concerning its planned exploration drilling program, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a) (12) (i), (ii), (iv)). Shell has documented its contacts with the North Slope subsistence communities, as well as the substance of its communications with subsistence stakeholder groups.

Additional meetings with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation are scheduled.

The following mitigation measures, plans and programs, are integral to this POC and were developed during consultation with potentially affected subsistence groups and communities. These measures, plans, and programs to monitor and mitigate potential impacts to subsistence users and resources will be implemented by Shell during its exploration drilling operations in the Chukchi Sea. The mitigation measures Shell has adopted and will implement during its Chukchi Sea exploration drilling operations are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in the Alaska Arctic OCS since the 1980s and efforts to engage with local subsistence communities to understand their concerns and develop mitigation measures to address those concerns. This most recent version of Shell's planned mitigation measures was presented to community leaders and subsistence user groups starting in January 2009 and has evolved since in response to information learned during the consultation process.

To minimize any cultural or resource impacts from its exploration operations, Shell will continue to implement the following additional measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

(1) Communications

- Shell has developed a Communication Plan and will implement this plan before initiating exploration drilling operations to coordinate activities with local subsistence users, as well as Village Whaling Captains' Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi Sea during Shell's proposed exploration drilling activities.

- Shell will employ local subsistence advisors (SAs) from the Chukchi Sea villages that are potentially impacted by Shell's exploration drilling activities. The SAs will provide consultation and guidance regarding the whale migration and subsistence activities. There will be one per village, working approximately 8-hr per day and 40-hr per week during each drilling season. The SA will use local knowledge (Traditional Knowledge) to gather data on subsistence lifestyle within the community and provide advice on ways to minimize and mitigate potential negative impacts to subsistence resources during each drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; coordinating with the Com and Call Center personnel; and advising how to avoid subsistence conflicts.

(2) Aircraft Travel

- Aircraft over land or sea shall not operate below 1,500 ft. (457 m) altitude unless engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings), or in an emergency situation.

- Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft. (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers.

(3) Vessel Travel

- The drilling unit(s) and support vessels will enter the Chukchi Sea through the Bering Strait on or after 1 July, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting.

- The transit route for the drilling unit(s) and drilling support fleets will avoid known fragile ecosystems and the Ledyard Bay Critical Habitat Unit (LBCHU), and will include coordination through Com Centers.

- PSOs will be aboard the drilling unit(s) and transiting support vessels.

- When within 900 ft (274 m) of whales, vessels will reduce speed, avoid separating members from a group and avoid multiple changes of direction.

- Vessel speed will be reduced during inclement weather conditions in order to avoid collisions with marine mammals.

- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.

(4) ZVSP

- Airgun arrays will be ramped up slowly during ZVSPs to warn cetaceans and pinnipeds in the vicinity of the airguns and provide time for them to leave the area and avoid potential injury or impairment of their hearing abilities. Ramp ups from a cold start when no airguns have been firing will begin by firing a single airgun in the array. A ramp up to the required airgun array volume will not begin until there has been a minimum of 30 min of observation of the safety zone by PSOs to assure that no marine mammals are present. The safety zone is the extent of the 180 dB radius for cetaceans and 190 dB re 1 μPa rms for pinnipeds. The entire safety zone must be visible during the 30-min lead-in.to an array ramp up. If a marine mammal(s) is sighted within the safety zone during the 30-min watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15-30 min: 15 min for small odontocetes and pinnipeds, or 30 min for baleen whales and large odontocetes.

(5) Ice Management

- Real time ice and weather forecasting will be from SIWAC

(6) Oil Spill Response

- Pre-booming is required for all fuel transfers between vessels

The potentially affected subsistence communities, identified in BOEM Lease Sale, that were consulted regarding Shell's exploration drilling activities include: Barrow, Wainwright, Point Lay Point Hope, Kotzebue, and Deering. Additionally, Shell has met with subsistence groups including the Alaska Eskimo Whaling Commission (AEWC), Inupiat Community of the Arctic Slope (ICAS), and the Native Village of Barrow, and presented information regarding the proposed activities to the North Slope Borough (NSB) and Northwest Arctic Borough (NWAB) Assemblies, and NSB and NWAB Planning Commissions during 2014. In July 2014, Shell conducted POC meetings in Chukchi villages to present information on the proposed 2015 drilling season. Shell supplemented the IHA application with a POC addendum to incorporate these POC visits. Throughout 2014 and 2015 Shell anticipates continued engagement with the marine mammal commissions and committees active in the subsistence harvests and marine mammal research.

Shell continues to meet each year with the commissioners and committee heads of Alaska Beluga Whale Committee, the Nanuuq Commission, Eskimo Walrus Commission, and Ice Seal Committee jointly in co-management meetings. Shell held individual consultation meetings with representatives from the various marine mammal commissions to discuss the planned Chukchi exploration drilling program. Following the drilling season, Shell will have a post-season co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

Shell attended the 2012-2014 Conflict Avoidance Agreement (CAA) negotiation meetings in support of exploration drilling, offshore surveys, and future drilling plans. Shell will do the same for the upcoming 2015 exploration drilling program. Shell states that it is committed to a CAA process and will negotiate an agreement every year it has planned activities.

4.2 Effects of Alternative 2

Under this alternative, NMFS would issue an IHA to Shell for the proposed exploration drilling program in the Chukchi Seas during the 2015 Arctic open-water season with required mitigation, monitoring, and reporting requirements as discussed in Chapter 2 of this EA. However, under this alternative activities in the Chukchi Sea would cease at the end of September instead of the end of October (as under Alternative 1). There are no other differences in the activities between Alternatives 1 and 2. As part of NMFS' action, the mitigation and monitoring described later in this EA would be undertaken as required by the MMPA, and, as a result, no injury or mortality of marine mammals is expected and no adverse impact on the annual reproductive or survival rates of affected species. Potentially affected marine mammal species under NMFS' jurisdiction include: bowhead, beluga, killer, gray, minke, fin, and humpback whales; harbor porpoise; and bearded, spotted, ringed, and ribbon seals.

4.2.1 Effects on Marine Mammals

As with Alternative 1, noise exposure and vessel activity are the primary mechanisms by which activities associated with exploration drilling program in the Chukchi Sea could directly or indirectly affect marine mammals under Alternative 2. Potential impacts from noise exposure, habitat degradation, and vessel activity would be the same as described above in Section 4.1.1, and that discussion is not repeated here.

The primary difference regarding potential impacts to marine mammals under Alternative 2 compared to Alternative 1 is the numbers and types of species that would be exposed to activities in the Chukchi Sea. Additionally, impacts to certain marine mammal species migrating across both the Beaufort and Chukchi Seas would be reduced.

Bowhead whales migrate westward from the Canadian Beaufort Sea through the U.S. Beaufort and Chukchi Seas in September and October. Although some individuals have been sighted in the northeastern Chukchi Sea during summer months (Clarke et al., 2011c; Ireland et al., 2008), bowheads are typically not found in U.S. waters until late August or early September in the fall. Bowhead whales increased in the Chukchi Offshore Monitoring in Drilling Area (COMIDA) in September and October 2008 through 2010, with sighting rates highest in October (Clarke et al., 2011c). This was similar to the previously observed distribution during surveys conducted from 1989 through 1991 (Clarke et al., 2011c). Under Alternative 2, Shell would be required to cease operations in the Chukchi Sea by the end of September. Therefore, fewer bowhead whales would be impacted by the proposed Chukchi Sea exploration drilling program because Shell would stop operating before the majority of the population reaches the Chukchi Sea Lease Sale 193 area. Temporal segregation by size and sex class occurs during the spring and fall migrations. In the spring, the first wave consists of sub-adults, the second of larger whales, and the third is comprised of even larger whales and cows with calves (NMFS, 2008; Rugh, 1990; Suydam and George, 2004). The reverse order is seen in the fall throughout the migration corridor (Koski and Miller, 2009; Noongwook et al., 2007); however, the cows with calves typically occur later in the migration in the fall as well. Therefore, fewer cows with calves would be impacted, as operations would cease before that portion of the population reaches the Chukchi Sea Lease Sale 193 area.

Beluga whales from both the eastern Chukchi Sea stock overwinter in the Bering Sea and then migrate to coastal estuaries, bays, and rivers in the spring (Allen and Angliss, 2010). Although individuals from this stock can be found in U.S. Chukchi Sea waters during the summer, open-water period, they are typically found further north than Shell's proposed exploration drill sites in waters around 79-80º North latitude. Beluga whales have been noted migrating westward back through the Chukchi Sea in September and October southward to the Bering Sea. Therefore, as with the bowhead whales, if Chukchi Sea operations cease at the end of September instead of the end of October, fewer beluga whales would be exposed to activities associated with the exploration drilling program in the Chukchi Sea.

Impacts to other cetacean species and to ice seals would be the same under Alternative 2 as for Alternative 1 in the Chukchi Sea. However, the duration of those impacts would be lessened under Alternative 2, as Shell would cease operations in the Chukchi Sea at the end of September instead of the end of October. Overall, impacts to marine mammals are anticipated to have minor to moderate effects. Impacts would only occur during the time that the animals are in the ensonified areas and are not anticipated to persist for long periods of time.

4.2.2 Effects on Subsistence

There would likely be a reduction in possible impacts to subsistence activities in the Chukchi Sea communities of Wainwright, Point Hope, Point Lay, Kivalina, and Kotzebue under this alternative compared to Alternative 1. If Shell ceases operations at the end of September instead of the end of October, there would be no temporal overlap with fall whaling activities. Although, as described above in Section 4.1.2 under Alternative 1, the likelihood of Shell's Chukchi Sea exploration drilling program affecting fall whaling in the Chukchi Sea is small, the potential would be reduced even further under Alternative 2.

4.3 Effects of Alternative 3

Under this alternative, NMFS would issue an IHA to Shell for the proposed exploration drilling program in the Chukchi Ses during the 2015 Arctic open-water season with required mitigation, monitoring, and reporting requirements as discussed in Chapter 2 of this EA. However, under this alternative Shell would only be able to drill one well to total depth (rather than four). Multiple MLCs and "spuds" (a type of partial well where an initial casing is set) may be drilled in a given season, but Shell could only access the hydrocarbon-bearing zone or zones of one well per year. There are no other differences between Alternatives 1 and 3. As part of NMFS' action, the mitigation and monitoring described earlier in this EA would be undertaken as required by the MMPA. We would not expect there to be any injury or mortality of marine mammals from Alternative 3 and no impact on the reproductive or survival rates of affected species. Potentially affected marine mammal species under NMFS' jurisdiction include: bowhead, beluga, killer, gray, minke, fin, and humpback whales; harbor porpoise; and bearded, spotted, ringed, and ribbon seals.

4.3.1 Effects on Marine Mammals

As with Alternative 1, noise exposure and vessel activity are the primary mechanisms by which activities associated with exploration drilling program in the Chukchi Sea could directly or indirectly affect marine mammals under Alternative 3. Potential impacts from noise exposure, habitat degradation, and vessel activity would be the same as described above in Section 4.1.1, and that discussion is not repeated here.

The primary differences regarding potential impacts to marine mammals under Alternative 3 relative to Alternative 1 are the number and type of species that would be exposed to activities in the Chukchi Sea. For example, if Shell completed drilling its one well to total depth and associated exploration drilling program activities by late August, the numbers of bowhead and beluga whales that could potentially be impacted would be significantly reduced (if those species would be impacted at all at that time of year). Additionally, impacts to certain marine mammal species migrating across both the Chukchi Sea would be reduced. This would be similar to what was described above for Alternative 2. While Alternative 3 may reduce impacts to marine mammals in a given season, it could mean that impacts are incurred over more open-water seasons than originally anticipated, as Shell may need to add additional years to the programs.

4.3.2 Effects on Subsistence

The effects of Alternative 3 on subsistence would be similar to and not be more than wha is described for Alternative 2 (and not Alternative 1). There would also be no additional effects to subsistence activites in the Chukchi Sea beyond those described under Alternatives 2 and 3. Alternative 3 has the potential to prolong the direct and indirect impacts on the economy because Shell would need to continue drilling operations in subsequent years; however, impacts to the economy would be lower in any single drilling season. These impacts are not anticipated to be significant.

4.4 Effects of Alternative 4—No Action Alternative

Under the No Action Alternative, NMFS would not issue an IHA to Shell for the proposed exploration drilling program in the Chukchi Sea, based on our inability to make one or more of the findings required for an IHA. The No Action Alternative would effectively preclude Shell from engaging in drilling operations, as approval of the exploration plans by BOEM is contingent upon Shell receiving an IHA from NMFS. If this alternative were selected, the impact on the environment from not conducting the proposed exploration drilling program in 2015 means that:

1) Adverse impacts on marine mammals, principally bowhead whales, would not be expected as the associated noise generated by the drilling, support, and ZVSP activities that have the potential to result in Level B (behavioral) harassment would not exist;
2) Adverse impacts on the Inupiat subsistence hunts would not occur as marine mammals would not be affected and would not have cause to deflect further from shore (other than the natural variation due to heavy and low ice years);
3) Adverse impacts on the marine habitat would not occur as the drilling vessels and associated support vessels would not be conducting drilling activities within the U.S. Chukchi Sea; and
4) A cessation or delay in offshore drilling activities by Shell will result either in unrecoverable costs with the potential for an increased level of activity in future years in an attempt to recover costs or in the displacement of activities and potential impacts to other offshore locations.

4.5 Estimation of Takes

For purposes of evaluating the potential significance of the "takes" by harassment, estimations of the number of potential takes are discussed in terms of the populations present. The specific number of takes considered for the authorizations is developed via the MMPA process, and the analysis in this EA provides a summary of the anticipated numbers that would be authorized to give a relative sense of the nature of impact of NMFS' proposed action. The methods to estimate take by harassment and present estimates of the numbers of marine mammals other than bowhead, gray, and beluga whales that might be affected during Shell's proposed exploration drilling programs are described in detail in Shell's IHA applications and the *Federal Register* notice of proposed IHA, which can be accessed at NMFS website at: http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm, and incorporated by reference.

Regarding potential takes of bowhead, gray, and beluga whales, NMFS later realized that data used in that document only included sighting data from 2012 and 2013. Upon consulting with NMFS Alaska Regional Office (AKRO) and the National Marine Mammal Laboratory (NMML), we realized that using sighting data covering 2008-2014 will lead us to more accurate density estimates of these three species. In addition, NMFS also revised the detectability bias f(0) in density calculation for the bowhead whale based on Ferguson and Clarke (2013). Therefore, NMFS is revising the take estimates of bowhead, gray, and beluga whales based on these updates to the density estimates.

Also for beluga whales, two populations are known to occur in the proposed exploration drilling area: the East Chukchi Sea population and the Beaufort Sea population. The precise percentage of each stock that could be taken is not known. Therefore, the following methods are used to estimate beluga takes in the study area.

Beluga whale densities used to estimate potential exposures were calculated from aerial survey data collected by the National Marine Mammal Laboratory (NMML) from July through October of 2008–2014. To reflect differences in abundance between seasons, data from July and August were pooled to produce a "Summer" density and data from September and October were pooled to produce a "Fall" density. Since individuals of the two stocks cannot be distinguished visually, these data represent individuals from both stocks to the extent that both stocks are present in the Chukchi Sea during the two seasons.

Few individuals from either stock are likely to be present near the planned activities in July and August because the spring migrations of both stocks beyond the lease sale area are largely complete by early July. The spring migration of the Beaufort Sea Stock occurs much earlier in the season compared to the Chukchi Sea stock, thus, beluga whales present in the Chukchi Sea in July and August are most likely from the Eastern Chukchi Sea Stock. Therefore, it is assumed that the average observed Summer (July–August) density of 0.0010 individuals/km^2 is entirely composed of individuals from the Eastern Chukchi Sea Stock.

Since the two stocks migrate at similar times through the Chukchi Sea in the fall and one cannot distinguish them visually, the pooled September–October beluga density received from NMML (0.0100 individuals/km^2) represents the presence of both stocks. The current abundance estimate for the Eastern Chukchi Sea Stock is 3,710 individuals and the abundance estimate for the Beaufort Sea Stock is 39,258 individuals (Allen and Angliss 2014) resulting in a combined total stock estimate of 42,968 individuals. The Eastern Chukchi Sea Stock is, therefore, 8.6% of the combined population and the Beaufort Sea Stock is 91.4%. Multiplying the observed density of 0.0100 individuals/km^2 by these percentages results in a density estimate of 0.0009 individuals/km^2 for the Eastern Chukchi Sea Stock and 0.0091 individuals/km^2 for the Beaufort Sea Stock. The Eastern Chukchi Sea Stock density estimate for the Fall period is therefore slightly lower than the density estimate for the Summer.

Conservative measures were applied when when calculating exposure estimates. These conservative methods and related considerations include:

- Application of a 1.3 dB re 1 μPa rms safety factor to the source level of each continuous

sound source prior to sound propagation modeling of areas exposed to Level B thresholds;
- Binning of similar activity scenarios into a representative scenario, each of which reflected the largest exposed area for a related group of activities;
- Modeling numerous iterations of each activity scenario at different drill site locations to identify the spatial arrangement with the largest exposed area for each;
- Assuming 100 percent daily turnover of populations, which likely overestimates the number of different individuals that would be exposed, especially during non-migratory periods;
- Expected marine mammal densities assume no avoidance of areas exposed to Level B thresholds (with the exception of bowhead whale, for which 50% of individuals were assumed to demonstrate avoidance behavior); and;
- Density estimates for some cetaceans include nearshore areas where more individuals would be expected to occur than in the offshore Burger Prospect area (e.g., gray whales).

The marine mammal species NMFS determined likely to be taken by Level B harassment incidental to Shell's proposed exploration drilling program in the U.S. Chukchi Sea are: bowhead, beluga, killer, fin, gray, humpback, and minke whales; harbor porpoise; and bearded, ribbon, ringed, and spotted seals. Any takes that occur are anticipated to result from noise propagation from the drillship, ice management/icebreaking activities, and the airguns used for the ZVSP surveys and would take the form of Level B behavioral harassment. Table 5 presents the number of each species that might be affected by the proposed exploration drilling program, the total number of each species that might be affected, and the percentage of the populations or stocks.

Table 5. The total number of potential exposures of marine mammals to sound levels ≥120 dB re 1 µPa rms or ≥160 dB re 1 µPa rms during the Shell's proposed drilling activities in the Chukchi Sea, Alaska, 2015. Estimates are also shown as a percent of each population

Species	Abundance	Number potential exposure	% Estimated population
Beluga (Beaufort Sea)	42,968	1,318	3.40%
Beluga (E. Chukchi Sea)	3,710	344	9.3%
Killer whale	2,084	14	0.8%
Harbor porpoise	48,215	294	0.6%
Bowhead whale	19,534	1,083	5.5%
Fin whale	1,652	14	0.8%
Gray whale	19,126	834	4.4%
Humpback whale	20,800	14	0.1%
Minke whale	810	41	5.1%
Bearded seal	155,000	1,722	1.1%
Ribbon seal	49,000	96	0.2%
Ringed seal	300,000	50,433	16.8%
Spotted seal	141,479	1,007	0.7%

4.6 Large and Very Large Oil Spill Analysis

An oil spill is not part of the proposed action (i.e., issuance of an IHA for the take of marine mammals incidental to conducting an exploration drilling program) nor is it part of the specified activities considered by NMFS. Therefore, an oil spill is neither a direct nor an indirect effect of the proposed action. Additionally, the likelihood of a large or very large oil spill occurring at either of the two proposed program sites is extremely remote. The likelihood of a large or very large (i.e. ≥1,000 barrels or ≥150,000 barrels, respectively) oil spill occurring during Shell's proposed programs has been estimated to be low. A total of 35 exploration wells have been drilled between 1982 and 2003 in the Chukchi and Beaufort Seas, and there have been no incidents of loss of well control or a blowout resulting from the loss of well control. In addition, no blowouts resulting from a loss of well control have occurred from the approximately 98 exploration wells drilled within the Alaskan OCS (MMS, 2007a; BOEMRE, 2011). Based on modeling conducted by Bercha (2008), the predicted frequency of an exploration well oil spill in waters similar to those in the Chukchi Sea, Alaska, is 0.000612 per well for a blowout sized between 10,000 bbl to 149,000 bbl and 0.000354 per well for a blowout greater than 150,000 bbl. Although the probability of such an event is discountable, NMFS nonetheless acknowledges this is a potential issue and describes the potential environmental effects associated with a large or very large oil spill.

Shell has implemented several design standards and practices to reduce the already low probability of an oil spill occurring as part of its operations. The wells proposed to be drilled in the Arctic are exploratory and will not be converted to production wells; thus, production casing will not be installed, and the well will be permanently plugged and abandoned once exploration drilling is complete. Shell has also developed and will implement the following plans and protocols: Shell's Critical Operations Curtailment Plan; IMP; Well Control Plan; and Fuel Transfer Plan. Many of these safety measures are required by the Department of the Interior's interim final rule implementing certain measures to improve the safety of oil and gas exploration and development on the Outer Continental Shelf in light of the Deepwater Horizon event (see 75 FR 63346, October 14, 2010). Operationally, Shell has committed to the following to help prevent an oil spill from occurring in the Chukchi Sea:

- Shell's Blow Out Preventer (BOP) was inspected and tested by an independent third party specialist;
- Further inspection and testing of the BOP have been performed to ensure the reliability of the BOP and that all functions will be performed as necessary, including shearing the drill pipe;
- Shell will conduct a function test of annular and ram BOPs every 7 days;
- A second set of blind/shear rams will be installed in the BOP stack;
- Full string casings will typically not be installed through high pressure zones;
- Liners will be installed and cemented, which allows for installation of a liner top packer;
- Testing of liners prior to installing a tieback string of casing back to the wellhead;
- Utilizing a two-barrier policy; and
- Testing of all casing hangers to ensure that they have two independent, validated barriers at all times.

Recent BOEM NEPA documents contain additional information and evaluations of effects from oil and the potential from oil spills from these activities on physical, biological, and socioecnomic resources. Those documents also explain key differences between the Macondo incident in the Gulf of Mexico in April 2010 and the locations proposed by Shell in the Arctic for exploration drilling. Some of the more notable differences include the water depth and total pressure (both of which are lower in the Arctic). The information contained in those documents is hereby incorporated by reference.

4.6 Cumulative Effects

Cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative impacts may occur when there is a relationship between a proposed action and other actions expected to occur in a similar location or during a similar time period, or when past or future actions may result in impacts that would additively or synergistically affect a resource of concern. In other words, the analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR §1508.7). These relationships may or may not be obvious. Actions overlapping within close proximity to the proposed action can reasonably be expected to have more potential for cumulative effects on "shared resources" than actions that may be geographically separated. Similarly, actions that coincide temporally will tend to offer a higher potential for cumulative effects.

Actions that might permanently remove a resource would be expected to have a potential to act additively or synergistically if they affected the same population, even if the effects were separated geographically or temporally. The proposed action considered here is not be expected to result in the removal of individual cetaceans or pinnipeds from the population or to result in harassment levels that might cause animals to permanently abandon preferred feeding areas or other habitat locations, so concerns related to removal of viable members of the populations are not implicated. This cumulative effects analysis more appropriately focuses on those activities that may temporally or geographically overlap with the proposed activity such that repeat harassment effects warrant consideration for potential cumulative impacts to the potentially affected 12 marine mammal species and their habitats.

Cumulative effects may result in significant effects even when the Federal action under review is insignificant when considered by itself. The CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe but to focus on those effects that are truly meaningful. This section analyzes the addition of the effects of the proposed action (i.e., the issuance of an IHA to Shell for the take of marine mammals incidental to conducting an offshore exploration drilling program in the U.S. Chukchi Seas) to the potential direct and indirect effects of other factors that may, in combination with the proposed action, result in greater effects on the environment than those resulting solely from the proposed action. Cumulative effects on affected resources that may result from the following activities—seismic survey activities, vessel and air traffic, oil and gas exploration and development in Federal and state waters, subsistence harvest activities, military activities, industrial development, community development, and climate change—within the proposed EA project area are discussed in the following subsections.

4.6.1 Past Commercial Whaling

Commercial hunting between 1848 and 1915 caused severe depletion of the bowhead population(s) that inhabits the Bering, Chukchi, and Beaufort (BCB) Seas. This hunting is no longer occurring and is not expected to occur again. Woodby and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woodby and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Data indicate that what is currently referred to as the BCB Seas stock of bowheads is increasing in abundance.

Similar to bowhead whales, most stocks of fin whales were depleted by commercial whaling (Reeves et al., 1998) beginning in the second half of the mid-1800s (Schmitt et al., 1980; Reeves and Barto, 1985). In the 1900s, hunting for fin whales continued in all oceans for about 75 years (Reeves et al., 1998) until it was legally ended in the North Pacific in 1976. Commercial hunting for humpback whales resulted in the depletion and endangerment of this species. Prior to commercial hunting, humpback whales in the North Pacific may have numbered approximately 15,000 individuals (Rice, 1978). Unregulated hunting legally ended in the North Pacific in 1966.

None of the alternatives would authorize lethal takes or serious injury of any marine mammal species, and none of the activities or action alternatives are expected to lead to future commercial harvesting of whales. Therefore, there is no potential for there to be additive or cumulative effects with the proposed action.

4.6.2 Subsistence Hunting

4.6.2.1 Bowhead Whales

Indigenous peoples of the Arctic and Subarctic have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the AEWC through a cooperative agreement between the AEWC and NMFS.

Currently, Native Alaskan hunters from 11 communities harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. Bowheads are hunted at Gambell and Savoonga on St. Lawrence Island, and along the Chukotkan coast. On the northward spring migration, harvests may occur by the villages of Wales, Little Diomede, Kivalina, Point Lay, Point Hope, Wainwright, and Barrow. During their westward migration in autumn, whales are harvested by Kaktovik, Nuiqsut, and Barrow. At St. Lawrence Island, fall migrants can be hunted as late as December (IWC, 2004). The status of the population is closely monitored, and these activities are closely regulated.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during the following periods and in the following areas: during their northward spring migration in the Bering Sea, the Chukchi Sea in the spring lead system, and in the Beaufort Sea spring lead system near Barrow; their fall westward migration in subsistence hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; hunting along the Chukotka coast; and hunting in wintering areas near St. Lawrence Island. Lowry et al. (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding. When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck, and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive harpoon used in the hunt, the boat motors, and any sounds made by the injured whale.

Noise and disturbance from subsistence hunting is as a seasonally and geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil and gas-related activities, add additional stressors to marine mammals. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential stressors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, is monitored, managed, and regulated, and helps to determine the resilience of the population to other stressors that could potentially cause lethal takes. The sustained growth of the Bering-Chukchi-Beaufort Seas bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003; NMFS, 2003), it is unlikely the proposed action when analyzed in light of this source of mortality will contribute to a significant effect on the recovery and long-term viability of this population.

4.6.2.2 Beluga Whales

The subsistence take of beluga whales within U.S. waters is reported by the Alaska Beluga Whale Committee (ABWC). The annual subsistence take of the Beaufort Sea stock of beluga whales by Alaska Natives averaged 25 belugas during the 5-year period from 2002-2006 (Allen and Angliss, 2011). The annual subsistence take of Eastern Chukchi Sea stock of beluga whales by Alaska Natives averaged 59 belugas landed during the 5-year period 2002-2006 based on reports from ABWC representatives and on-site harvest monitoring. Data on beluga that were struck and lost have not been quantified and are not included in these estimates (Allen and Angliss, 2011). As with bowhead whale subsistence hunts, noise during the hunts may disturb other animals not struck and taken for subsistence purposes. Again, the disturbance occurs during specific time periods in specific locations to which other activities could add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

4.6.2.3 Ice Seals

The Division of Subsistence, Alaska Department of Fish and Game (ADF&G) maintains a database that provides additional information on the subsistence harvest of ice seals in different regions of Alaska (ADF&G 2000a,b). Information on subsistence harvest of bearded seals has been compiled for 129 villages from reports from the Division of Subsistence and a report from the Eskimo Walrus Commission (Sherrod, 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. As of August 2000, the subsistence harvest database indicated that the estimated number of bearded, ribbon, ringed, and spotted seals harvested for subsistence use per year are 6,788, 193, 9,567, and 244, respectively (Allen and Angliss, 2011).

At this time, there are no efforts to quantify the current level of harvest of bearded seals by all Alaska communities. However, the USFWS collects information on the level of ice seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicate that an average of 239 bearded seals were harvested annually in Little Diomede, Gambell, Savoonga, Shishmaref, and Wales from 2000 to 2004, 13 ribbon seals from 1999 to 2003, and 47 ringed seals from 1998 to 2003 (Allen and Angliss, 2010). Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were 21 bearded seals harvested during the walrus harvest monitoring period on St. Lawrence Island in 2005, 41 in 2006, and 82 in 2007. There were no ringed seals harvested on St. Lawrence Island in 2005, 1 in 2006, and 1 in 2007. The mean annual subsistence harvest of spotted seals in north Bristol Bay from this stock over the 5-year period from 2002 through 2006 was 166 seals per year. No ribbon seal was harvested between 2005 and 2007 (Allen and Angliss, 2010).

4.6.2.4 Contributions of the Alternatives to Cumulative Effects of Subsistence Hunting

Alternative 4 would not contribute any additional effects beyond those already analyzed to the cumulative effects from subsistence hunting, as the IHAs would not be issued. Alternatives1, 2, and 3 would allow for the issuance of IHAs for the take of marine mammals incidental to conducting exploration drilling programs in the Beaufort and Chukchi Seas during the open-water season. However, under all alternatives except the no-action alternative, Shell would shut down prior to the fall whaling at Kaktovik and Nuiqsut and not operate until the hunts were completed, thus avoiding concurrent impacts. Additionally, the proposed action is not anticipated to result in injury or mortality of any marine mammals; therefore, there would not be additional deaths beyond those from subsistence hunting activities. While both activities (i.e., the proposed action and subsistence hunting) can disturb marine mammals, NMFS considers the contribution of such disturbance to overall cumulative effects to be minimal because of the limited duration and mitigation measures that would be required under the IHA, which are included to reduce impacts to the lowest level practicable (see Chapter 52).

4.6.3 Climate Change

Sections 4.3.3 and 5.1.3 in BOEM's Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final Second Supplemental Environmental Impact Statement (BOEM, 2015) and Section 3.1.4.4 in NMFS' Draft EIS on the Effects of Oil and Gas Activities in the Arctic Ocean (NMFS, 2011) describes changes to climate in the Arctic environment. That information is summarized here and incorporated herein by reference. Evidence of climate change in the Arctic appears to generally agree with climate modeling scenarios of greenhouse gas warming. Such evidence suggests (NSIDC, 2011a):

- Air temperatures in the Arctic are increasing at an accelerated rate;
- Year-round sea ice extent and thickness has continually decreased over the past three decades;
- Water temperatures in the Arctic Ocean have increased;
- Changes have occurred to the salinity in the Arctic Ocean;
- Rising sea levels;
- Retreating glaciers;
- Increases in terrestrial precipitation;
- Warming permafrost in Alaska; and
- Northward migration of the treeline.

Associated with climate change is a change in ocean chemistry known as ocean acidification. This phenomenon is described in the IPCC Fourth Assessment Report (IPCC, 2007a), a 2005 synthesis report by members of the Royal Society of London (Raven et al., 2005), and an ongoing BOEM-funded study (Mathis, 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice and from increased CO_2 uptake by the sea as a result of ice retreat (Fabry et al., 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater. At this time, we do not know the precise timeframe, or the series of events that would need to occur before an adverse population level effect on the marine mammals or other resources in the Arctic would be realized. However, this information is unobtainable at this time due to the fact that such conditions do not exist to conduct studies.

Bowhead and other Arctic whales are associated with and well adapted to ice-covered seas with leads, polynyas, open water areas, or thin ice that the whales can break through to breathe. Arctic coastal peoples have hunted bowheads for thousands of years, but the distribution of bowheads in relation to climate change and sea ice cover in the distant past is not known. It has been suggested that a cold period 500 years ago resulted in less ice-free water near Greenland, forcing bowheads to abandon the range, and that this in turn led to the disappearance of the Thule culture. However, it is not clear if larger expanses and longer periods of ice-free water would be beneficial to bowheads. The effect of warmer ocean temperatures on bowheads may depend more on how such climate changes affect the abundance and distribution of their planktonic prey rather than the bowheads' need for ice habitat itself.

Climate change associated with Arctic warming may also result in regime change of the Arctic Ocean ecosystem. Sighting of humpback whales in the Chukchi Sea during the 2007 Shell seismic surveys (Funk et al., 2008), 2009 COMIDA aerial survey (Clarke et al., 2011c), and south of Point Hope in 2009 while transiting to Nome (Brueggeman, 2010) may indicate the expansion of habitat by this species as a result of ecosystem regime shift in the Arctic. These species, in addition to minke and killer whales, and four pinniped species (harp, hooded, ribbon, and spotted seals) that seasonally occupy Arctic and subarctic habitats may be poised to encroach into more northern latitudes and to remain there longer, thereby competing with extant Arctic species (Moore and Huntington, 2008).

In the past decade, geographic displacement of marine mammal population distributions has coincided with a reduction in sea ice and an increase in air and ocean temperatures in the Bering Sea. Continued warming is likely to increase the occurrence and resident times of subarctic species such as spotted seals and bearded seals in the Beaufort Sea. The result of global warming would significantly reduce the extent of sea ice in at least some regions of the Arctic (ACIA, 2004).

Ringed seals, which are true Arctic species, depend on sea ice for their life functions, and give birth to and care for their pups on stable shorefast ice. The reductions in the extent and persistence of ice in the Beaufort Sea almost certainly could reduce their productivity (NRC, 2003b), but at the current stage, there are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska ringed seal stock (Allen and Angliss, 2010). In addition, spotted seals and bearded seals would also be vulnerable to reductions in sea ice, although insufficient data exist to make reliable predictions of the effects of Arctic climate change on these two species (Allen and Angliss, 2010).

The implications of the trends of a changing climate for bowheads and other Arctic cetaceans are uncertain, but they may be beneficial, in contrast to effects on ice-obligate species such as ice seals, polar bears, and walrus (ACIA, 2004). There will be more open water and longer ice-free seasons in the arctic seas, which may allow them to expand their range as the population continues to recover from commercial whaling. However, this potential for beneficial effects on bowheads and other whales will depend on their ability to locate sufficient concentrations of planktonic crustaceans to allow efficient foraging. Since phytoplankton blooms may occur earlier or at different times of the season, or in different locations, the timing of zooplankton availability may also change from past patterns. Hence, the ability of bowheads to use these food sources may depend on their flexibility to adjust the timing of their own movements and to find food sources in different places (ACIA, 2004). In addition, it is hypothesized that some of the indirect effects of climate change on marine mammal health would likely include alterations in pathogen transmission due to a variety of factors, effects on body condition due to shifts in the prey base/food web, changes in toxicant exposures, and factors associated with increased human habitation in the Arctic.

With the large uncertainty of the degree of impact of climate change to Arctic marine mammals, NMFS recognizes that warming of this region which results in the diminishing of ice could be a concern to ice dependent seals, walrus, and polar bears. Nonetheless, NMFS considers the effects of the proposed action and the specified activity proposed by Shell during 2015 on climate change are too remote and speculative at this time to conclude definitively that the issuance of MMPA IHAs for the 2015 proposed exploration drilling programs would contribute to climate change, and therefore a reduction in Arctic sea ice coverage. More research is needed to determine the magnitude of the impact, if any, of global warming to marine mammal species in the Arctic and subarctic regions. Finally, any future oil and gas activities that may arise as a result of this year's open-water exploration drilling programs would likely need to undergo separate permit reviews and analyses.

4.6.4 Oil and Gas Exploration and Development

4.6.4.1 Marine and Seismic Surveys

BOEM-permitted seismic surveys have been conducted in the Federal waters of the Beaufort Sea since the late 1960's/early 1970's (MMS 2007a). For activities since July 2010, NMFS issued an IHA to Shell to take 8 species of marine mammals by Level B behavioral harassment incidental to conducting site clearance and shallow hazards surveys in the Beaufort and Chukchi Seas on August 6, 2010 (75 FR 49710; August 13, 2010). No seismic surveys were conducted in the Beaufort Sea in 2011. In 2012, NMFS issued an IHA to BP Exploration (Alaska), Inc. (BPXI) and ION Geophysical (ION) to take small numbers of marine mammals by harassment incidental to conducting open-water 3D OBC seismic surveys in the Simpson Lagoon of the Beaufort Sea (77 FR 40007; July 6, 2012) and in-ice 2D seismic surveys in the Beaufort and Chukchi Seas (77 FR 65060; October 24, 2012), respectively. In 2013, NMFS issued IHAs to Shell for its open-water marine surveys in the Chukchi Sea (78 FR 47496; August 5, 2013), and to ION for its 2D seismic survey in the Chukchi Seas (78 FR 51147; August 20, 2013). In 2014, NMFS issued IHAs to BP for its 3D seismic survey in the Beaufort Sea (79 FR 36730; June 30, 2014) and its geophazard survey in the Beaufort Sea (79 FR 36769; June 30, 2014), and to SAE for its marine seismic survey in the Beaufort Sea (79 FR 51963; September 2, 2014).

Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, seismic surveys will continue in the Beaufort and Chukchi Seas into the near future and be dependent on: (1) the amount of data that is collected in recent years; and (2) what the data indicate about the subsurface geology. NMFS anticipates that future marine and seismic surveys will continue as the demands on oil and gas are expected to grow worldwide.

Available information does not indicate that marine and seismic surveys for oil and gas exploration activities has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of marine mammals species and populations in the Arctic region. For example, data indicate that the BCB bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred. There is no evidence of long-term displacement from habitat (although studies have not specifically focused on addressing this issue). Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. Monitoring studies indicate that most fall migrating whales avoid an area with a radius about 20 - 30 km around a seismic vessel operating in nearshore waters (Miller *et al.* 2002). NMFS is not aware of data, however, that indicate that such avoidance is long-lasting after cessation of the activity or results in significant adverse effects to subsistence users.

An assessment of the cumulative impacts of seismic surveys must consider the decibel levels used, location, duration, and frequency of operations from the surveys as well as other reasonably foreseeable seismic-survey activity. In general, the high-resolution, site clearance and shallow hazards surveys are of lesser concern regarding impacts to cetaceans than the deep 2D/3D surveys. High-resolution and 2D/3D seismic surveys usually do not occur in proximity to each other, as they would interfere with each others' information collection methods. This operational requirement indirectly minimizes the potential for adverse effects on marine mammals that could otherwise be exposed to areas with overlapping intense noise originating from multiple sources.

Finally, most marine and seismic surveys are limited in space and usually occur during the open water season to avoid data acquiring systems being damaged by floating ice. Therefore, the cumulative effects of the proposed exploration drilling activities in the Chukchi Sea are not likely to appreciably impact the existing marine environment.

4.6.4.2 Oil and Gas Development and Production

Oil and gas exploration and production activities have occurred on the North Slope since the early 1900's, and production has occurred for more than 50 years. Since the discovery and development of the Prudhoe Bay and Kuparuk oil field, more recent fields generally have been developed not in the nearshore environment, but on land in areas adjacent to existing producing areas. Pioneer Natural Resources Co. is developing its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit.

BPXA is currently producing oil from an offshore development in the Northstar Unit, which is located between 3.2 and 12.9 km (2 and 8 mi) offshore from Point Storkersen in the Beaufort Sea. This development is the first in the Beaufort Sea that makes use of a subsea pipeline to transport oil to shore and then into the Trans-Alaska Pipeline System. The Northstar facility was built in State of Alaska waters on the remnants of Seal Island ~9.5 km (6 mi) offshore from Point Storkersen, northwest of the Prudhoe Bay industrial complex, and 5 km (3 mi) seaward of the closest barrier island. The unit is adjacent to Prudhoe Bay, and is approximately 87 km (54 mi) northeast of Nuiqsut, an Inupiat community. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea.

On November 6, 2009, BPXI submitted an application requesting NMFS issue regulations and subsequent LOAs governing the taking of marine mammals, by both Level B harassment and serious injury and mortality, incidental to operation of the Northstar development in the Beaufort Sea, Alaska. Construction of Northstar was completed in 2001. The proposed activities for 2012-2017 include a continuation of drilling, production, and emergency training operations but no construction or activities of similar intensity to those conducted between 1999 and 2001.

In addition, Shell conducted two exploratory drilling activities at exploration wells in the Beaufort (77 FR 27284; May 9, 2012) and Chukchi (77 FR 27322; May 9, 2012) Seas, Alaska, during the 2012 Arctic open-water season (July through October). In December 2012, Shell submitted two additional IHA applications to take marine mammals incidental to its proposed exploratory drilling in Beaufort and Chukchi Seas during the 2013 open-water season. However, Shell withdrew its application in February 2013.

Existing onshore and offshore oil and gas development and production facilities and their associated pipelines have the potential to release industrial chemicals or spill oil. Oil spills from offshore production activities are of concern because as additional offshore oil exploration and production occurs at such projects as the Liberty, Oooguruk, and Nikaitchuq, occurs, the potential for large spills in the marine environment increases. In addition to potential oil spills from industry infrastructure, the potential also exists for oil/fuel spills to occur from associated support vessels, fuel barges, and even aircraft. However, this risk is considered slight in ice-free waters, and any spills which result from the proposed action would most likely be of small volume, and are not considered a serious threat to marine mammals in the action area. Even if a small oil/fuel spill were to occur, it would be easily avoidable by marine mammals. Any impacts to them most likely would include temporary displacement until cleanup activities are completed and short-term effects on health from the ingestion of contaminated prey (MMS 2007). However, a large scale oil spill in the Arctic could be devastating to the region's marine ecosystem.

Drilling for oil and gas in the Arctic generally occurs from natural and artificial islands, caissons, bottom-founded platforms, and ships and submersibles. With varying degrees, these operations produce low-frequency sounds with strong tonal components. Drilling occurs once a lease has been obtained for oil and gas development and production and may continue through the life of the lease.

Underwater sound from vessels operating near the Northstar facility in the Beaufort Sea often were detectable as far as 30 km offshore, while sounds from construction, drilling, and production reached background values at 2 - 4 km. BPXA began to use hovercraft in 2003 to access Northstar, which have proven to generate considerably less underwater noise than similar-sized conventional vessels and, therefore, may be an attractive alternative when there is concern over underwater noise (Richardson and Williams 2004). Richardson and Williams (2004) concluded that there was little effect from the low-to-moderate level, low-frequency industrial sounds emanating from the Northstar facility on ringed seals during the open-water period, and that the overall effects of the construction and operation of the facility were minor, short term, and localized, with no consequences to the seal populations as a whole.

Drilling activities are expected to occur in the near future on Beaufort leases and the Northstar facility and within the Hammerhead leases and shoreline within the Point Thomson unit. Drilling in State waters is also expected to occur. Other active drilling will take place on land but at sites away from coastlines.

Given this information, the duration and frequency of drilling within marine mammal habitat is anticipated to be relatively minimal and impacts are not expected to be significant. Therefore, the potential impacts of the proposed exploration drilling activity on the affected environment are expected to be indirect and minor.

4.6.5 Vessel Traffic and Movement

Increasing vessel traffic in the Northwest Passage increases the risks of oil and fuel spills and vessel strikes of marine mammals. The proposed exploration drilling programs are not expected to contribute substantially to these risks, as exploration will occur in ice-free seas and because most marine mammals are likely to actively avoid close proximity to the operations.

Vessel traffic in the Alaskan Arctic generally occurs within 12.4 mi (20 km) of the coast and usually is associated with fishing, hunting, cruise ships, icebreakers, Coast Guard activities, and supply ships and barges. No extensive maritime industry exists for transporting goods. Traffic in the Beaufort and Chukchi Seas, at present, is limited primarily to late spring, summer, and early autumn.

For cetaceans, the main potential for effects from vessel traffic is through vessel strikes and acoustic disturbance. Regarding sound produced from vessels, it is generally expected to be less in shallow waters (i.e., background noise only by 6.2 mi [10 km] away from vessel) and greater in deeper waters (traffic noise up to 2,480 mi [4,000 km] away may contribute to background noise levels) (Richardson et al., 1995). Aside from the drillships and other vessels associated with the drilling programs, seismic-survey vessels, barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contribute to overall ambient noise levels in some regions of the Beaufort and Chukchi Seas. Whaling boats (usually aluminum skiffs with outboard motors) contribute noise during the fall whaling periods in the Alaskan Beaufort Sea. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Overall, the level of vessel traffic in the Alaskan Arctic, either from oil and gas-related activities or other industrial, military, or subsistence activities, is expected to be greater than in the recent past. With increased ship traffic, there could potentially be deep water port construction in the region.

Ships using the newly opened waters in the Arctic likely will use leads and polynyas to avoid icebreaking and to reduce transit time. Leads and polynyas are important habitat for polar bears and belugas, especially during winter and spring, and heavy shipping traffic could disturb polar bears and belugas during these times.

Alternative 1 would not contribute any additional effects beyond those already analyzed to the cumulative effects from vessel traffic and movement, as the IHAs would not be issued to Shell for the two proposed programs. Alternatives 2, 3, and 4 would increase the number of vessels in the Beaufort and Chukchi Seas for approximately four months, as each program will require approximately 8-12 vessels, including the drillships, icebreakers, and other support vessels. However, because of the overall low level of vessel traffic in the Alaskan Arctic, the proposed action is not anticipated to add significantly to the cumulative effects from vessel traffic and movement in the region.

4.7.6 Conclusion

Based on the analyses provided in this section, NMFS has determined that the proposed Shell exploration drilling program in the Chukchi Seas during the 2015 open-water season would not be expected to add significant impacts to overall cumulative effects on marine mammals from past, present, and future activities. The potential impacts to marine mammals and their habitat are expected to be minimal based on the limited noise footprint. Although it is not a component of the proposed action or Shell's specified activities, NMFS has also determined that there is a very low likelihood of a large or very large oil spill event occurring as a result of the proposed programs. In addition, mitigation and monitoring measures described in Chapter 2 are expected to further reduce any potential adverse effects.

Chapter 5 List of Preparers and Agencies Consulted

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Agencies Consulted
No other persons or agencies were consulted in preparation of this EA.

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