Shell Exploration & Production

February 12, 2013

Shell
3601 C Street, Suite 1000
Anchorage, AK 99503
Tel. (907) 646-7112
Email susan.childs@shell.com
Internet http://www.shell.com/

U.S. Department of the Interior
Bureau of Ocean Energy Management
Attn: David Johnston
Regional Supervisor Leasing and Plans
3801 Centerpoint Drive, Suite 500
Anchorage, AK 99503-5820

Re: Ancillary Activity Notice of Intent for 2013 Marine Surveys in the Chukchi Sea, Alaska

Dear Mr. Johnston:

Shell Gulf of Mexico Inc. (Shell) provides the following Notice of Intent (NOI) to the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM) under 30 Code of Federal Regulation (CFR) §550.208 to complete an open water marine survey program in the Chukchi Sea during 2013. As described herein, Shell plans to conduct geophysical and geotechnical surveys (aka Open Water Marine surveys) designed to gather additional data relative to ice gouge and seafloor soil properties in select offshore areas of the Chukchi Sea. These surveys will be conducted from a single vessel that is proposed for use in both the Beaufort and Chukchi Seas. These surveys are continuations of similar data acquisition programs conducted by Shell in the Beaufort Sea beginning in 2006, and in the Chukchi Sea in 2008, with the addition of the geotechnical investigations.

This NOI includes three documents within which the project purpose, scope and assessment of environmental effects and mitigation measures are described, these are:

- Enclosure: *Environmental Report, Chukchi Sea 2013 Open Water Marine Survey Program* - January 2013;
- Attachment A: *Marine Mammal Monitoring and Mitigation Plan for Geophysical and Geotechnical and Surveys in the Alaskan Chukchi and Beaufort Seas in 2013* – December 2012; and
- Attachment B: *Plan of Cooperation 2013 Proposed Open Water Marine Surveys Program, Chukchi Sea and Beaufort Sea, Alaska* – December 2012.

The content of this letter fulfills information required within 30 CFR § 550.208 (1), (3), and (4). Some details of the requisite information for 30 CFR § 550.208 (2), *Provide the names of the vessel, its operator, and the person(s) in charge; the specific type(s) of operations you will conduct; and the instrumentation/techniques and vessel navigation system you will use;* will be provided after Shell contracts the vessel and its operator to be used to conduct the 2013 geophysical and geotechnical surveys.

Purpose

Shell plans to conduct offshore ice gouge and geotechnical surveys in the Chukchi Sea during the 2013 open water season. Per requisite information in 30 CFR § 550.208 (2), the project purpose and scope are detailed in sections 1 and 2 of the enclosed *Environmental Report* in addition to their summary in this transmittal letter. These planned surveys will generate data necessary to evaluate the physical environment in the vicinity of Shell's on-going Chukchi Sea exploration program for the possible future location of facilities to support continued exploration and possible development activities. Offshore ice

gouge surveys investigate the depth width, orientation, frequency, and distribution of ice gouges and will profile the seafloor surface as well as gain important bathymetric data. Geotechnical surveys characterize seafloor and shallow sub-seafloor sediments. Both of these surveys are focused on limited areas in order to characterize the seafloor and shallow seafloor sediments at prospective drilling locations and along potential pipeline routes.

Marine Survey Instrumentation

Per requisite information in 30 CFR § 550.208 (2), the following acoustic instrumentation, or similar, is proposed for use:

- Dual Frequency side scan sonar (100-500 kilo Hertz [kHz]) or similar;
- Single-beam bathymetric sonar (24-500 kHz) or similar;
- Multi-beam bathymetric sonar (200-300 kHz) or similar;
- Shallow sub-bottom profiler (3.5 kHz) or similar;
- Ultra short baseline acoustic positioning system;
- Seabed rotary drilling/Piston Core/Cone penetrometer (CPT) system;
- Jumbo piston core with downhole CPT;
- Navigation instrumentation; and
- Magnetometer.

Shell plans to conduct the geophysical and geotechnical surveys from a single vessel. The vessel has not been selected or contracted, although it is expected to be of similar size to the *M/V Nordica*, *Fennica* or *Ocean Pioneer*. Generalized descriptions and specifications of the vessel types under consideration for use in the geophysical and geotechnical surveys are presented in Section 2 of the enclosed *Environmental Report.*

Marine Survey Schedule and Locations

Per 30 CFR § 550.208 (3), Table 1 provides a tentative schedule for the performance of these geophysical and geotechnical surveys during 2013.

Table 1 Tentative Schedule for the 2013 Geophysical and Geotechnical Surveys in the Beaufort and Chukchi Seas

Survey	Schedule	Priorities and Options
Offshore Ice Gouge	Marine vessel surveys mid July – mid October	May conduct surveys in Chukchi Sea first –moving to the Beaufort Sea in early August and returning to the Chukchi on or before August 25th to complete Chukchi surveys
Geotechnical	Marine vessel surveys mid July – mid October	May conduct surveys in Chukchi Sea first –moving to the Beaufort Sea in early August and returning to the Chukchi on or before August 25th to complete Chukchi surveys

Figure 1.0-1 of the enclosed *Environmental Report* depicts the prospective areas from which data will be collected. The data will be collected on several of Shell's Chukchi Sea OCS leases and in areas between Shell's Chukchi Sea OCS leases and the boundary of state and federal waters.

Potential for Impact to the Environment and/or Subsistence Resources

Per 30 CFR § 550.208 (4), the collection of attachments to this letter summarize Shell's evaluation and analysis of the program impacts to the environment and/or subsistence. These attachments support Shell's on-going commitment to incorporate mitigation measures in the execution of marine programs that eliminate or minimize any effects of marine programs. For the geophysical and geotechnical surveys of 2013 it is anticipated that the low-energy acoustic sources used to complete these surveys will have no effect or negligible effect on either the environment or subsistence resources. The marine survey program will be conducted in accordance with the Marine Mammal Monitoring and Mitigation Plan (4MP; Attachment B) prepared by Shell as support documentation for an Incidental Harassment Authorization (IHA) application submitted to the National Marine Fisheries Service on December 26, 2012. The IHA application, in accordance with 50 CFR 216.101-108, also includes a description of the marine survey program. The survey vessel will be staffed with Protected Species Observers, who will be present during survey activities and who will adhere to the requirements of the 4MP. The vessel will communicate regularly with the Chukchi Sea Communication Centers and/or Call Centers. As with all Chukchi Sea activities, Shell will operate the marine survey program under the provisions of Shell's Plan of Cooperation and the Communication Plan with Chukchi Sea subsistence communities for 2013. As of the date of this letter, Shell has not received the 2013 IHA. When received, Shell will provide a copy of the IHA to BOEM.

A request for a Letter of Authorization (LOA) for incidental harassment of polar bears and Pacific walrus, in accordance with 50 CFR 18.121-129, also was submitted to the U.S. Fish and Wildlife Service on January 22, 2013. As of the date of this letter, Shell has not received the LOA. When received, Shell will provide a copy of the LOA to the BOEM.

Please contact me at (907) 646-7112 or e-mail: susan.childs@shell.com or contact Pauline Ruddy (907-771-7243; pauline.ruddy@shell.com) for further information.

Thank you.

Susan Childs
Alaska Venture Support Integrator, Manager

Enclosure w/Attachments:

Environmental Report, Chukchi Sea 2013 Open Water Marine Survey Program - January 2013

Attachment A: Marine Mammal Monitoring and Mitigation Plan for Geophysical and Geotechnical and Surveys in the Alaskan Chukchi and Beaufort Seas in 2013 – December 2012

Attachment B: Plan of Cooperation 2013 Proposed Open Water Marine Surveys Program, Chukchi Sea and Beaufort Sea, Alaska – December 2012

Environmental Report

Shell 2013 Open Water Survey Program Chukchi Sea, Alaska

February 2013

Submitted to:

U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503

Submitted by:

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

THIS PAGE
INTENTIONALLY
LEFT BLANK

TABLE OF CONTENTS

List of Tables

List of Figures

ACRONYMS & ABBREVIATIONS

AAAQS	Alaska Ambient Air Quality Standards
AEWC	Alaska Eskimo Whaling Commission
APDES	Alaska Pollutant Discharge Elimination System
BOEM	Bureau of Ocean Energy Management
BO	Biological Opinion
BOD	Biological oxygen demand
CFR	Code of Federal Regulations
CO	carbon monoxide
COTPZ	Captain of the Port Zone
CPT	cone penetrometer test
CWA	Clean Water Act
DP	dynamic positioning
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	Essential Fish Habitat
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Analysis
EIS	Environmental Impact Statement
EP	Revised Chukchi Sea Exploration Plan
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ESA	Endangered Species Act
IHA	Incidental Harassment Authorization
LBCHU	Ledyard Bay Critical Habitat Unit
LOA	Letter of Authorization
MARPOL	International Convention for the Prevention of Pollution from Ships
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MSA	Magnuson-Stevens Fishery Conservation Act
MSD	Marine Sanitation Device
NAAQS	National Ambient Air Quality Standards
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NPDES	National Pollutant Discharge Elimination System
NO_x	nitrogen oxide
NSB	North Slope Borough
OCS	Outer Continental Shelf

OSRP	Oil Spill Response Plan
Pb	lead
$PM_{2.5}$	particulate matter < 2.5 micrometers
PM_{10}	particulate matter < 10 micrometers
PSO	Protected Species Observer
PTS	permanent threshold shift
SA	Subsistence Advisor
TTS	temporary threshold shift
TSS	total suspended solids
USBA	Ultra short baseline acoustic (postioning system)
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
ULSD	ultra low sulfur diesel
VGP	Vessel General Permit (EPA NPDES)
VOC	volatile organic compound

UNITS OF MEASURE

µ	micrometer
µPa	micro-Pascal
bbl	barrel (petroleum)
ft	foot
ft^2	square foot
ft^3	cubic foot
hr	hour
Hz	hertz
in	inch
kHz	kilohertz
km	kilometer
km^2	square kilometer
m	meter
m^2	square meter
m^3	cubic meter
mi	statute mile
mi^2	square mile
mL	milliliter
mm	millimeter

1.0 INTRODUCTION

Shell plans to conduct geophysical and geotechnical surveys in the Chukchi Sea during the 2013 open water season. These planned surveys, collectively referred to herein as Shell's 2013 Chukchi Sea Open Water Survey Program, are a continuation of the survey program Shell initiated in 2008 to generate data necessary to evaluate the physical environment in the vicitiny of Shell's on-going Chukchi Sea exploration program for the possible future location of facilities to support continued exploration and possible development activities. These investigations include geophysical surveys such as ice gouge surveys, and geotechnical studies, such as coring and cone penetrometer investigations. The studies will be conducted both on Shell lease blocks in the Outer Continental Shelf (OCS) and at locations between the lease blocks and the coastline. All the surveys will be conducted in Federal waters of the OCS. The survey area is depicted in Figure 1.0-1.

Per regulations at 30 Code of Federal Regulations (CFR) § 550.207 these types of geophysical surveys are considered ancillary activities. A permit is not required from the Bureau of Ocean Energy Management (BOEM) for ancillary activities (30 CFR § 550.105); however, prior to authorizing the activities BOEM requires notification by the operator at least 30 days in advance of the planned surveys (30 CFR § 550.208). The notification must:

(1) Sign and date the notice;

(2) Provide the names of the vessel, its operator, and the person(s) in charge; the specific type(s) of operations you will conduct; and the instrumentation/techniques and vessel navigation system you will use;

(3) Provide expected start and completion dates and the location of the activity; and

(4) Describe the potential adverse environmental effects of the proposed activity and any mitigation to eliminate or minimize these effects on the marine, coastal, and human environment.

This Environmental Report (ER) was prepared to support these notification requirements. In 2011, Shell prepared an Environmental Impact Assessment (EIA) in association with proposed exploration drilling in the Chukchi Sea (see Appendix F of the Revised Chukchi Sea Exploration Plan [EP]) which detailed the resources at risk in the Chukchi Sea including the survey area for the 2013 open water survey program. This EIA provides a comprehensive analysis of potential impacts associated with the EP activities, of which a few are germane to the open water surveys program (e.g., vessel traffic, subsistence, etc.). The reader is referred to the EIA for its comprehensive description of the resources and discussion of impact analyses that are germane to the activities of this open water marine surveys program though on a smaller scale.

Stakeholder Engagement

Shell has developed and implemented a comprehensive stakeholder engagement program for sharing information about its proposed OCS activities, including the marine survey program. An integral component of stakeholder engagement was to develop a Plan of Cooperation (POC) which ensures that Shell's OCS operations will be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and the subsistence activities and resources of the North Slope. The POC supports both Shell's Incidental Harassment Authorization (IHA) requested from the National Marine Fisheries Service (NMFS) and Letter of Authorization

(LOA) requested from the U.S. Fish and Wildlife Service (USFWS) for the 2013 Chukchi Sea open water marine survey program.

Stakeholders consulted in development of the POC included the North Slope Borough (NSB), local residents and local organizations, federal and state agencies, and non-governmental organizations as well as the Alaska Eskimo Whaling Commission (AEWC) along with other marine mammal co-management groups. Shell held meetings in October, November, and December of 2012 (Tables 1.0-1 and 1.0-2) during which the planned surveys were described and comments from the communities were gathered.

Table 1.0-1 Stakeholder Engagement Community Meetings

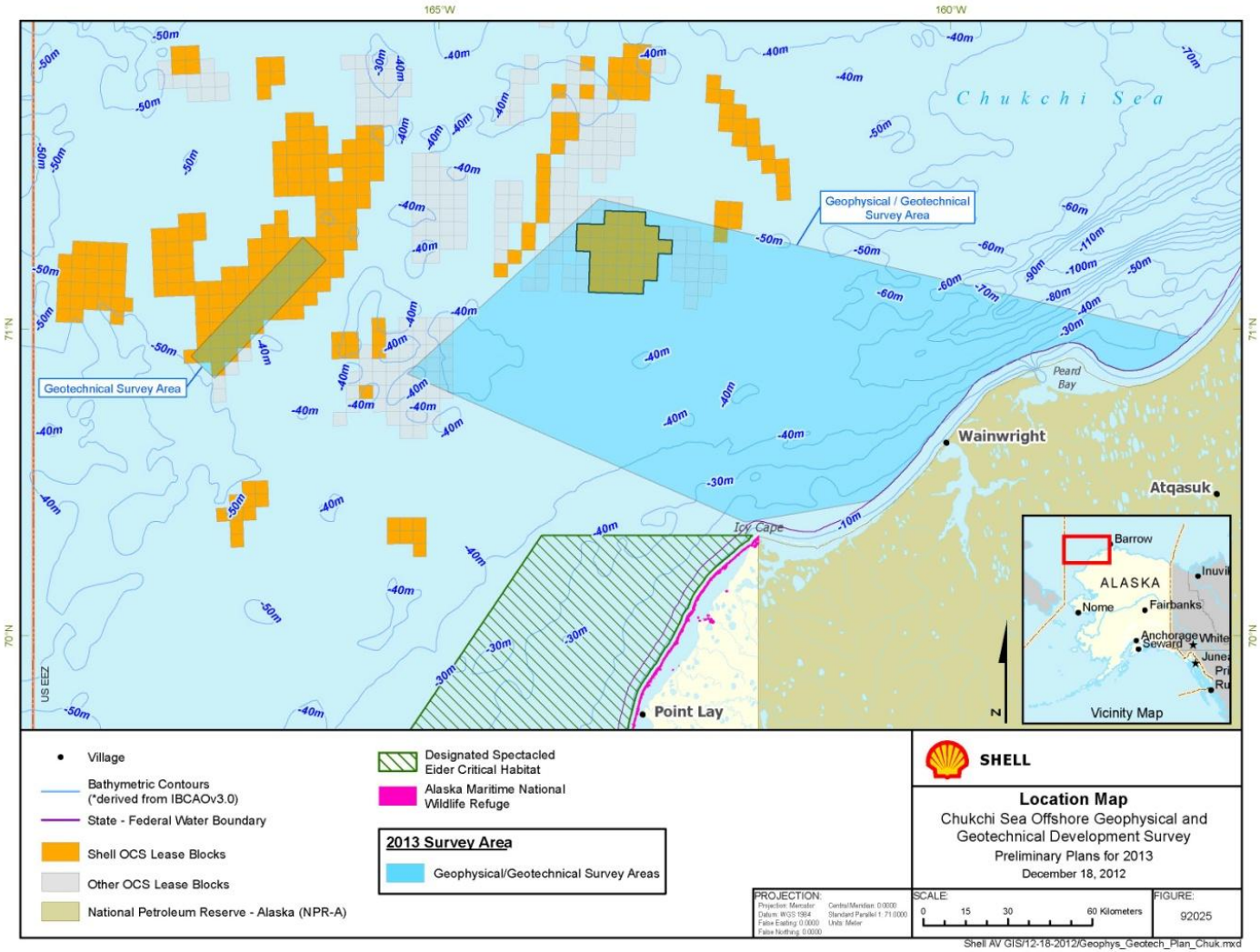
2012	Meeting Location	Meeting Attendees – Position
23 October	Point Lay	Plan of Cooperation Point Lay Community Meeting
24 October	Wainwright	Plan of Cooperation Wainwright Community Meeting
26 October	Kaktovik	Plan of Cooperation Kaktovik Community Meeting
29 October	Barrow	Plan of Cooperation Barrow Community Meeting
30 October	Nuiqsut	Plan of Cooperation Nuiqsut Community Meeting
6 November	Barrow	NSB Assembly Workshop Meeting

Table 1.0-2 AEWC and Marine Mammal Commission Meetings

2012	Meeting Location	Type of Meeting
13-14 December	Anchorage	Marine Mammal Commission Meeting - AEWC
17-18 December	Anchorage	Marine Mammal Commission Meeting[1]

[1] Attended by Alaska Beluga Whale Committee, Ice Seal Committee Alaska Nanuuq Commission and Eskimo Walrus Commission

Figure 1.0-1 Location Map for the 2013 Chukchi Sea Offshore Open Water Survey Program



2.0 PLANNED 2013 OPEN WATER SURVEY ACTIVITIES

Shell plans to conduct the following types of surveys in offshore federal waters in the Chukchi Sea during the open water season in 2013:

- Geotechnical investigations - approximately 28 geotechnical boreholes
- Geophysical investigations – approximately 621 mi (1,000 km) of ice gouge surveys

The surveys will be conducted within the portion of the Chukchi Sea indicated in Figure 1.0-1 in mid-July to mid-October 2013. The geotechnical and geophysical investigations will be conducted from the same vessel.

2.1 Geophysical and Geotechnical Equipment

The types of acoustic and geotechnical equipment intended for use during the geophysical and geotechnical surveys are indicated in Table 2.1-1 and described below.

Table 2.1-1 Proposed Equipment for 2013 Geophysical and Geotechnical Surveys

Equipment Type[1]	Ice Gouge Survey [2]	Geotechnical Survey [2]
Dual-frequency, side-scan sonar (100-500 kHz)	●	--
Single-beam, bathymetric sonar (24-500 kHz)	●	●
Multi-beam, bathymetric sonar (200-300 kHz or similar)	●	--
Shallow sub-bottom profiler	●	--
Ultra short baseline acoustic (USBA) positioning system	●	●
Magnetometer	●	●
Navigation Instrumentation	●	--
Jumbo Piston Corer / Downhole Cone Penetrometer (CPT) or Seabed Rotary Drilling System	--	●

[1] Equipment types may vary slightly from that listed, thus all equipment types are qualified with, “or similar”.
[2] ● – Proposed for use in 2013; -- – Not intended for this survey

2.2 Geophysical Investigations – Offshore Ice Gouge Surveys

Shell plans to conduct ice gouge surveys in 2013 in Federal waters of the OCS as part of its overall feasibility study to identify and evaluate seabed conditions in its Alaska prospects and in areas between the prospects and the coastline. Ice gouge information is required for the design of potential pipelines and pipeline trenching and installation equipment. Ice gouges are created by ice keels that project from the bottom of ice, and gouge the seafloor sediment as the ice moves with the wind or currents. Ice gouge features can be mapped and surveyed, and by surveying the same locations from year to year, new gouges can be identified and the rate of ice gouging can be estimated. The resulting ice gouge information will assist Shell in predicting the probability, frequency, orientation, and depth of future ice gouges.

Specific objectives of these surveys are to: (a) accumulate multi-year statistical data on ice gouge features along selected previously surveyed track lines, (b) provide data to delineate favorable areas for man-made seabed structures within the Burger Prospect, (c) provide data to delineate favorable corridors for buried in-field flow lines and pipelines between these favorable areas

within the Burger Prospect, and (d) provide data to delineate favorable corridors for a buried export pipeline between the Burger Prospect and shore.

During the 2013 ice gouge surveys, Shell plans to survey approximately 621 mi (1,000 km) of track lines within the areas denoted in Figure 1.0-1 in order to: (a) resurvey selected previously surveyed track lines for ice gouge features; and (b) map seafloor topography and characterize the upper 33 ft (10 m) of the seabed (seafloor and sub-seafloor) using acoustic methods. As depicted in Figure 2.2-1, the ice gouge surveys will be conducted using the conventional survey method where the acoustic instrumentation will be towed behind the survey vessel or mounted on the hull. The vessel travels along the track lines at a speed of 3.5-4.0 knots (4.0-4.6 mph). The ice gouge surveys are operated 24 hr per day, so barring weather or other problems the surveys could proceed at a rate of about 62 mi / day (100 km / day).

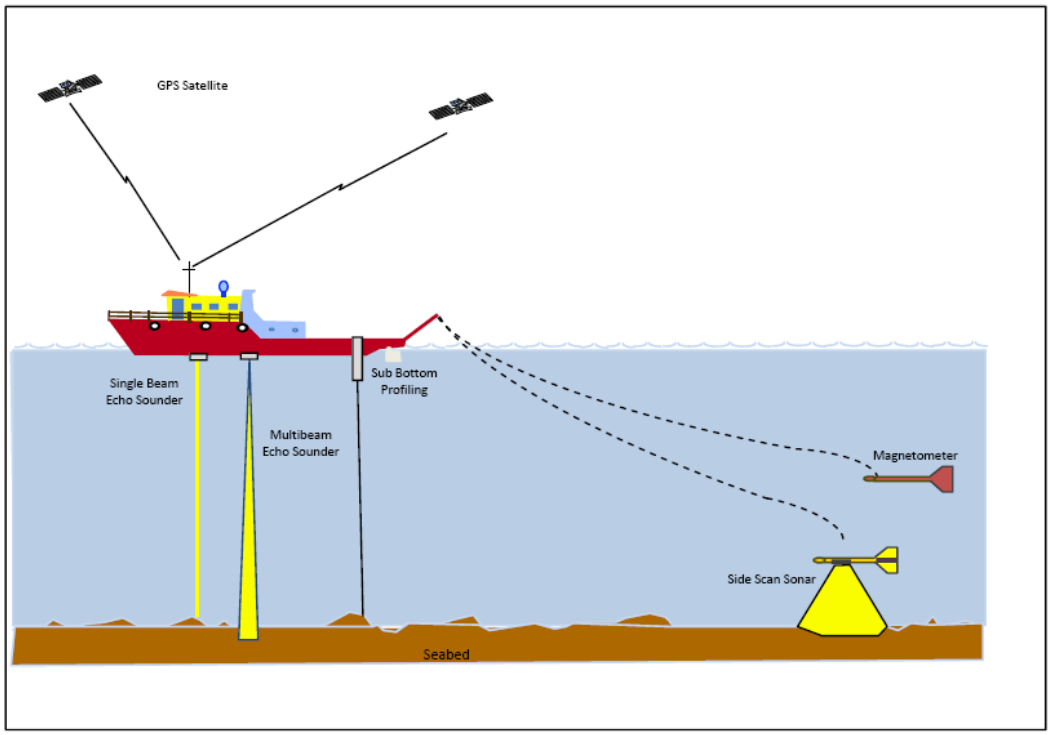


Figure 2.2-1 Schematic of Ice Gouge Survey Acquisition

2.3 Offshore Geotechnical Investigations

Shell plans to conduct geotechnical investigations in certain locations within its prospects, and in the area between these prospects and shore, to: (a) delineate potential favorable corridors for buried in-field flow lines and pipelines in the Burger Prospect and further to the west, and (b) delineate favorable corridors for a potential buried export pipeline between the Burger Prospect and shore. This program will consist of relatively shallow boreholes drilled to proposed depths over potential subsea pipeline routes.

A single vessel will be used to conduct the geotechnical investigation. The vessel will likely use single-beam sonar and ultra short baseline acoustic positioning. Shell plans to conduct this offshore geotechnical investigation in mid-July to mid-October, ice and weather permitting;

however, ice and weather conditions in 2013 and mitigation measures will influence the actual timing of geotechnical survey operations.

Geotechnical Borings

The geotechnical surveys will consist of up to about 28 boreholes drilled to proposed depths of about 50 ft. (15.2 m). The geotechnical work will be accomplished with a seabed drilling system (Figure 2.3-1) that can conduct rotary drilling, piston coring, and CPT soundings, or with a jumbo piston core / CPT system (Figure 2.3-2).

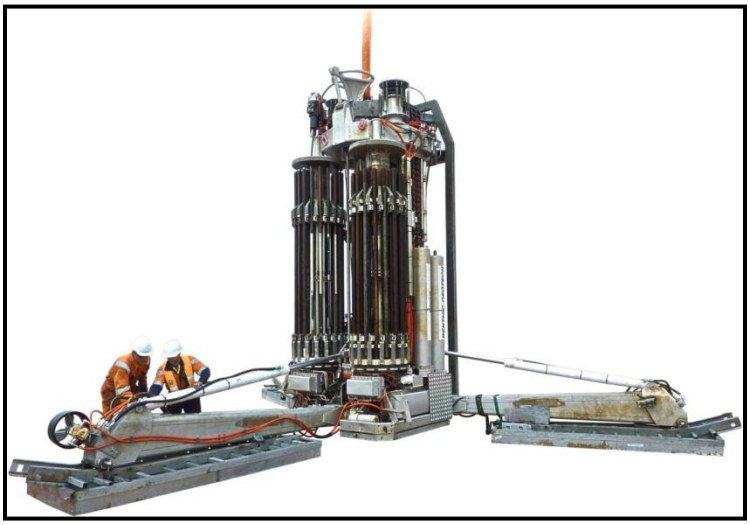


Figure 2.3-1 Schematic of Geotechnical Survey Acquisition with a Seabed Drilling System

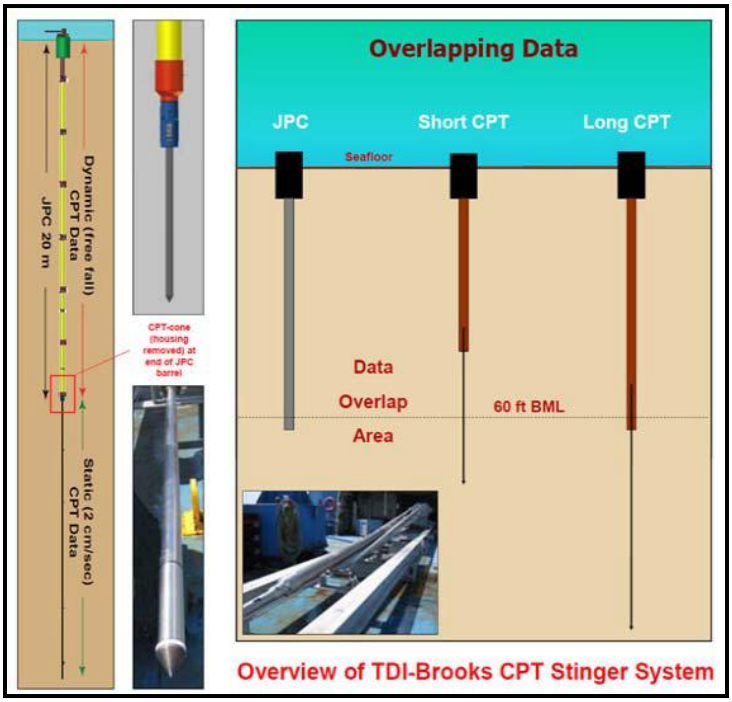


Figure 2.3-2 Schematic of Geotechnical Survey Acquisition with Piston Core / CPT System

During the drilling of the geotechnical boreholes, the geotechnical survey vessel will remain stationary relative to the seafloor by means of a dynamic-positioning (DP) system that automatically controls and coordinates vessel movements using bow and/or stern thrusters as well as the primary propeller(s).

If the seabed drilling system is utilized, the rotary drilling, coring, and CPT soundings would be conducted in the same borehole in one run per location. The borehole is cased from the mudline to the bottom of the borehole, which enables the drilling to be accomplished without the use of drilling muds. The casing is removed when the borehole is complete.

If the jumbo piston core / CPT system is used, then it is likely that the coring device will be launched 2-3 times per location, once for the cores, and 1-2 companion runs for CPT soundings.

2.4 Vessels

Shell plans to conduct the 2013 Chukchi Sea Open Water Survey Program with a single vessel. No regularly scheduled use of aircraft is planned. The vessel has not been selected or contracted. A general description of the type of marine vessels that would be used in the 2013 open water survey program is presented below. Specifications of vessels of the type that might be contracted, and have been used in the Chukchi Sea in the past are summarized below in Table 2.4-1; however, these are only provided as examples. Shell plans to contract a vessel that uses a DP system to control vessel motions and maintain drilling string deflections within operating limits while maintaining station over the borehole. The planned geophysical and geotechnical surveys will not require any chase/support vessels. The vessel will enter the Chukchi Sea at the beginning of the season and exit the Chukchi Sea at the end of the season. The surveys will be conducted on a 24 hr / day schedule.

Table 2.4-1 Specifications of Survey Vessels

Specification	*Ocean Pioneer* [1]	*Fugro Explorer* [1]	*Fugro Synergy* [1]	*Nordica* [1]
Length	205 ft (62.5 m)	261 ft (79.6 m)	349 ft 103.7 m	380 ft (116 m)
Width	40 ft (12.2 m)	52.5 ft (16.0 m)	64.5 ft (19.7 m)	85 ft (26 m)
Draft	14 ft (4.3 m)	17.1 ft (5.2 m)	21 ft (6.5 m)	27 ft (8.4 m)
Accommodations	35 berths	48 berths	84 berths	82 berths
Maximum Speed	14 knots (26 km/hr)	12 knots (22 km/hr)	16 knots (30 km/hr)	16 knots (30 km/hr)
Fuel Storage	1,963 bbl (312.2 m^3)	5,300 bbl (843 m^3)	8,472 bbl (1,347 m^3)	11,070 bbl (2 m^3)

[1] Specifications provided for these vessels as examples of vessels used in the past only

2.5 Mobilization and Schedule

Shell expects that the vessel that will be used for the 2013 Open Water Survey Program will be brought into the Chukchi Sea for the program at the beginning of the season, and will exit the Chukchi Sea at or before the end of the season. However, Shell also plans to have open water survey operations in the Beaufort Sea during the same season. The vessel used in the Chukchi

Sea may also be used in the Shell's Beaufort Sea open water survey program, so there may be some transit between the two theaters during the season.

In accordance with 33 CFR § 151, Subpart D, any of the vessels coming from another Captain of the Port Zone (COTPZ) will undergo one or more complete mid-ocean ballast water exchanges before entering U.S. waters or the Alaska COTPZ from another zone to prevent the unintentional introduction of non-native species into the Chukchi Sea.

Photograph 2-1 *Ocean Pioneer*

Photograph 2-2 *Fugro Explorer*

Photograph 2-3 *Fugro Synergy*

Photograph 2-4 *Nordica*

The schedule for the survey activities in the Chukchi Sea will depend on ice conditions and other factors. The survey vessel will transit through the Bering Strait into the Chukchi Sea on or after 1 July depending on ice conditions. The 1 July date for entry into the Chukchi Sea is in accordance with requirements in USFWS incidental take regulations. The 1 July entry is also responsive to concerns voiced by the local communities of Wainwright and Point Lay; these communities have requested that entry into the Chukchi Sea be delayed until after the walrus and beluga whale hunts.

The schedule for the geophysical and geotechnical working the Chukchi Sea and any work to be done on the Beaufort Sea will depend on weather, sea conditions, ice, and other factors. However, Shell expects to start work in the Chukchi Sea first, and then possibly transit to the Beaufort Sea to conduct surveys in that area, leaving the Beaufort Sea on or before 25 August

and returning to the Chukchi Sea. Work will then be completed in the Chukchi Sea, with the vessel exiting the Chukchi Sea before 31 October.

Given that access to the proposed areas where Shell plans to conduct activities is dependent on ice, weather, and coordinated avoidance of potential impacts to subsistence activities, Shell has estimated a broader range of time to conduct these surveys than if the surveys were not constrained. For example, without any of the above constraints, the time necessary to complete offshore ice gouge surveys could be as little as 13 days. Similarly, geotechnical surveys could possibly be completed in 28 days. However, these time estimates do not include transit time through the Chukchi and Beaufort Seas, transit between survey locations, potential stand-by time due to ice and/or weather, or crew changes and re-supply.

Crew Rotation

Shell has tentative plans for crew changes but these are subject to change. The marine crew on the vessel will likely not undergo any regular crew changes. The technical survey crew will change when operations switch from geotechnical investigations to the ice gouge survey. Select crew members such as PSOs and Shell representatives may also be rotated out. Shell has vessels and aircraft in the theatre that are part of the exploration drilling program, and these assets may be used to effect crew changes. It is likely that most crew changes will be carried out via vessel. Crew change may be accomplished when the vessel completes work in the Beaufort Sea and transits to the Chukchi Sea.

Refueling

No refueling is planned. The survey vessel to be used for the ice gouge surveys and geotechnical investigations will likely be a long range vessel capable of storing fuel in sufficient quantities for the season. Any refueling required by the vessel to be used would be done in Nome or possibly a vessel to vessel refueling using Shell's assets in the Chukchi Sea exploration drilling program, which include a fuel tanker.

Resupply

No major resupplies efforts are planned. There may be some small resupply consisting largely of stores for the galley. These small resupplies would likely be accomplished with the crew change operations.

2.6 Drilling Fluids for the Geotechnical Investigation

No drilling muds will be used. Seawater will be used to lubricate and cool the bit and transport cuttings to the surface if and when rotary drilling is conducted using the seabed drilling system. No drilling fluids are required for CPT soundings or piston coring by the seabed drilling system or the jumbo piston corer / CPT system.

2.7 Waste Management

The types and volumes of wastes that will be generated as a result of the 2013 Chukchi Sea open water survey program are described below.

Geotechnical Coring Wastes

Coring wastes as defined here include only drill cuttings as drilling muds will not be used. Drill cuttings are the geologic or earthen materials that are pulverized by the drill bit and brought to

the surface by the drilling fluids. Drill cuttings are chips of naturally occurring rocks including clays, limestone, shale, sand and other benign materials that pose no harm to the environment. Coring wastes will be generated only by the geotechnical investigations, and only if rotary drilling is conducted. No cuttings will be generated or discharged if the jumbo piston corer / CPT system is utilized. Ambient seawater is gathered in a bladder on the seabed drilling system and then pumped down the center of the drill stem and out the drill bit. The seawater then carries the cuttings from the drill bit to the seafloor surface where they are discharged via an eductor system.

Other Wastes

Other wastes that will be generated during the 2013 Chukchi Sea open water survey program and discharged to ocean waters in accordance with the International Convention for the Prevention of Pollution from Ships (Marine Pollution or MARPOL) include: gray water, backwater, deck drainage, de-salination wastes, non-contact cooling water, bilge water, and ballast water. Additional wastes that may be generated but will be either incinerated or held on the ship to be disposed of at regulated facilities outside of the Chukchi Sea area include: paper and wood products, glass and plastic materials, batteries, light bulbs, and used petroleum products and oily rags.

Combustible non-hazardous wastes such as paper and pallets generated may be incinerated onboard the survey vessel, which will be equipped with an incinerator. Food waste will also be incinerated on the survey vessel with incinerators. Any non-combustible wastes will be transported to shore and disposed of in a landfill approved for such wastes. Regulated wastes will be transported out of the Chukchi Sea and disposed at an approved licensed facility. Regulated wastes include such things as paint, solvents, unused chemicals, batteries, lamps, used oil, and glycol.

The survey vessel will operate under the requirements and stipulations of the U.S. Environmental Protection Agency's (EPA's) National Pollution Discharge Elimination System (NPDES) NPDES Vessel General Permit (VGP) and /or when they enter State waters and Alaska Pollution Discharge Elimination System (APDES) general permits well as meet the requirements set forth in MARPOL.

2.8 Air Emissions

Regulated air pollutants including the criteria pollutants of nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), lead (Pb) and particulate matter less than 10 micrometers in diameter (PM_{10}) and 2.5 micrometers ($PM_{2.5}$) will be emitted by the survey vessel engines and equipment. Mobile sources such as survey vessels are exempt from permitting under the Clean Air Act.

2.9 Oil Spill Prevention and Contingency Planning

The survey vessel will operate under its Vessel Response Plan. Shell is committed to conducting safe and environmentally responsible operations in the Chukchi Sea. To achieve this goal, oil spill prevention is a priority in all aspects of operations. Shell's Chukchi Sea Regional Exploration Program Oil Spill Response Plan (OSRP) emphasizes the prevention of oil pollution by employing the best control mechanisms for blowout prevention, fuel transfer operations, as well as implementing mandatory prevention training programs for field operating personnel.

Potential spills and their impacts were analyzed in the EIA (Shell 2011b) for the Revised Chukchi Sea Exploration Plan (Shell,2011a) Appendix F. For detailed information regarding these potential impacts see the EP.

2.10 Mitigation Measures

Some of the additional mitigation measures Shell has adopted and implements during its Chukchi Sea exploration drilling operations, and are relevant to an open water marine survey program, are listed below. These mitigation measures reflect Shell's experience conducting exploration drilling in Alaska since 1986 and its ongoing consultations with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. Aircraft are not expressly proposed to support the marine surveys program; however, in the remote chance aircraft, fixed-wing or rotary-winged, are used to support or assist an operation of these surveys, the aircraft travel mitigation measures have been included.

Communications

- Shell has developed a Communication Plan and will implement this plan before initiating 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 and Beaufort Seas during Shell's proposed marine surveys.
- Shell will employ local Subsistence Advisors (SA) from the Beaufort and Chukchi Sea villages that could potentially be impacted by Shell's planned activities. The SAs will provide consultation and guidance regarding the whale migration, subsistence activities concerns or conflicts; coordinate with subsistence users; report subsistence-related comments, and, advise on subsistence conflicts avoidance.

Aircraft Travel

- Aircraft, except shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings), or in an emergency situation to minimize disturbance to mammals and birds. 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.
- Aircraft will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on ice, or in the water.
- No rotary winged aircraft (helicopter) will not operate at an altitude lower than 3,000 ft (914 m) within 1 mi (1.6 km) of walrus groups observed on land.
- Shell will also implement non-PSO flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea. This flight will also help avoid disturbance of and collisions with birds.

Vessel Travel

- The vessel 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 vessel through the Chukchi Sea will avoid the Ledyard Bay Critical Habitat Unit (LBCHU) and will include coordination through Com Centers.
- PSOs will be aboard the survey vessel.
- The survev vessel will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on ice and in the water; 0.5 mi (0.8 km) of polar bears on land; and 1 mi (1.6 km) of groups of walruses when observed on land.
- Vessel speed is to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.
- The survey vessel will take all practical measures (i.e., reduce speed, change headings) to maintain a minimum 0.5 mi (0.8 km) operational exclusion zone around groups of 12 or more walruses encountered in the water. The vessel may not be operated in such a way as to separate members of a group of walruses.
- Shell will communicate and coordinate with the Com Centers regarding all vessel transit.

Air Emissions

- ULSD (0.0015 percent sulfur by weight) fuel will be purchased for the survey vessel, which will reduce SO_2 emissions by more than 97%.

3.0 RESOURCES AND CONDITIONS

This section provides descriptions of the environmental conditions and the physical, biological and socio-cultural resources of the survey area that could be affected by the 2013 Chukchi Sea Open Water Survey Program. More detailed descriptions can be found in BOEM's EIS for Lease Sale 193 (MMS 2007b) and Shell's EIA (Shell 2011b) for its Revised Chukchi Sea EP. Distances from the survey area to the coastline and the nearest villages are presented in Table 3.0-1.

Table 3.0-1 Distances from Chukchi Sea Villages to the Survey Area

Distance to Nearest Location within the Survey Area				
Barrow	**Wainwright**	**Point Lay**	**Point Hope**	**Coastline**
27 mi (44 km)	3.0 mi (4.8 km)	50 mi (81 km)	206 mi (332 km)	>3.0 mi (4.8 km)

3.1 Air Quality

EPA has designated the onshore area adjacent to the Chukchi Sea as Class II and in attainment for all criteria air contaminants. The existing air quality in the Chukchi Sea and adjacent onshore areas is considered to be good because of the lack of pollutant emission sources. Concentrations of regulated air pollutants are much lower in the area (AECOM 2010a,b,c,d; AECOM 2011a,b) than the maximum allowed by the National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS).

3.2 Oceanography and Water Quality

Water depths (Figure 1.0-1) over most of the survey area range from 40 to 160 ft (12-50 m) but the upper parts of the Barrow Canyon protrude into the northwestern part of the survey area where water depths approach 295 ft (90 m). There are no important shoals within the survey area. Hanna Shoal is located about 60 mi (96 km) north of the survey area. The seafloor over most of the survey area is largely flat and featureless, with the exception of the aforementioned Barrow Canyon area.

Water quality in the Chukchi Sea is considered to be relatively pristine (Naidu et al. 1997, MMS 2007b). The region is remote, and humans have little direct influence on the water quality because few people live in the vast region surrounding the Chukchi Sea. Contaminants that do occur in the Chukchi Sea are found only at very low levels (MMS 2007b). Hydrocarbon concentrations in the Chukchi Sea are on the order of 1 part per billion (ppb) or less, and are considered to be of natural origin.

3.3 Sediments

Shallow seafloor sediments of the Chukchi Sea consist of mud, gravelly mud, muddy gravel, gravelly sand, and muddy sand, and have been mapped by several investigators (McManus et al. 1969, Naidu 1988, Feder et al. 1989, Nelson et al. 1994). Surficial sediments over most of Shell's survey area are predominantly mud (Nelson et al. 1994). Surficial sediments in Shell's Burger Prospect in the northern part of the survey area consist of sandy mud with lesser amounts of gravel, with the mud (silt and clay) content of 22-85 percent (Neff et al. 2010).

Chukchi Sea sediments are relatively free of pollutants with metal concentrations comparable to other undeveloped areas of the arctic (Naidu et al. 1997). Neff et al. (2010) found concentrations of metals and hydrocarbons in sediments in the Burger Prospect area to be well within the range of non-toxic background concentrations reported for other Alaskan and Arctic coastal and shelf sediments. Average concentrations of all metals except for arsenic and barium were found to be lower than those reported for average marine sediment.

3.4 Lower Trophic Organisms

Phytoplankton

The greatest abundance of phytoplankton occurs in water depths of less than 16 ft (4.8 m) due to the inability of light to penetrate below these depths and through the ice layer (Gradinger et al. 2005). The Minerals Management Service (MMS 2007b) has reported that Chukchi Sea primary productivity Bay is generally higher in coastal areas, such as Ledyard and near Point Hope and Cape Lisburne, than in offshore areas. Dunton et al. (2003) reported a differing distribution of high primary productivity areas in the Chukchi Sea based chlorophyll 'a' concentration in seawater, with higher productivity occurring in offshore areas.

Zooplankton

Zooplankton includes larval forms of marine invertebrates and fish (meroplankton), as well as macroscopic crustaceans such as copepods. Larger species with weak swimming abilities may be present such as medusae (jellyfish), ctenophores (combjellies), chaetognaths (arrow worms), euphausiids (krill), amphipods, and mysids. Euphausiids, amphipods, and mysids are abundant in the Alaskan Chukchi Sea (Richardson et al. 1987) and are important prey for bowhead whales (Lowry 1993) and ringed seals (Frost and Lowry 1984). During summer and winter, calanoid copepods may dominate the zooplankton community, providing important prey for birds, whales, and fish (Craig et al. 1984, Lowry 1993).

In the Burger Prospect (northern part of survey area) in July-October of 2009 (Hopcroft et al. 2009, 2010), dominant taxa (by abundance) in the 150 µm net tows were barnacle larvae, larvacean *Fritillaria borealis*, *Pseudocalanus* copepods. the larvacean *Oikopleura vanhoeffeni*, the copepod *Calanus marshallae*, polychaete larvae, the chaetognath *Parasagitta elegans*, bivalve larvae, and the cnidarian *Aglantha digitale* all averaging more than 5 / m^3. Dominant taxa (by abundance) in the 505 µm net tows were the larvacean *Fritillaria borealis* was the only species averaging more than 100 / m^3, followed by the copepods *Calanus marshallae/glacialis, Eucalanus bungii*, barnacle larvae, and the chaetognath *Parasagitta elegans*, which averaged 3-13/m^3.

Benthic Communities

Benthic invertebrate communities include organisms living within sediments (infauna) or on the seafloor surface (epifauna). Stoker (1981) identified benthic invertebrate communities (cluster groups) across the Chukchi Sea; two Cluster Groups (VI and VIII) predominate in the survey area. Key species in Cluster Group VI include the polychaete worm *Maldane sarsi*, the brittle star *Ophiura sarsi*, the peanut worm *Golfingia margariticea*, and the clam *Astarte borealis.* Key species in Cluster Group VIII include the clams *Macoma calcarea*, *Nucula tenuis*, and *Yoldia hyperborea*, amphipod *Ponteporeia femorata*.

Dominant epifaunal groups in the Burger Prospect include the echinoderms (sea cucumbers, brittle stars, and sea stars), cnidarians (soft corals), mollusks (the welks *Buccinum* and *Neptunea*), tunicates, and crustaceans (barnacles, hermit crabs and snow crabs) (Blanchard et al. 2010). Brittle stars comprise about 74 percent of the biomass, sea cucumbers and crabs comprised about 6 percent, bivalves and gastropods comprised about 4 percent, and sea anemones, shrimp, and sea stars represent about 1-2 percent of the epifaunal biomass. Infaunal sampling collected 286 unique taxa, with dominant groups being the bamboo worm *Maldane glebiflex*, the seed shrimp Ostracoda, the smooth nutclam *Ennuncula tenuis*, and marine scuds (amphipods) *Photis* sp., and *Paraphoxus* sp (Blanchard et al. 2010).

Hard-bottom communities contain aggregations of macrophytic algae (large kelps), benthic microalgae, and benthic invertebrates associated with rocks and other hard substrate. No special benthic habitats or communities are known to occur in the survey area. Kelp beds have been identified approximately 16 mi (25 km) southwest of Wainwright at a depth between 36-43 ft (11-13 m) and a second kelp bed was located 12 mi (20 km) northeast of Peard Bay near Skull Cliff (Phillips and Reiss 1985a, 1985b; Mohr et al. 1957). These kelp beds are located just shoreward of the survey area. Benthic fauna in these hard-bottom habitats includes diverse epifaunal communities of isopod, copepod, amphipod, shrimp, and mollusks (BOEMRE 2011b)

Epontic Communities

Epontic communities are composed of organisms that live on or in the undersurface of sea ice. Timing of the epontic community bloom is important in providing food for zooplankton prior to the phytoplankton bloom. Abundance of sea-ice biota varies across seasons and years and is highly correlated to abiotic factors such as light and nutrient availability (Werner et al. 2007). Pennate diatoms and microflagellates are the most abundant of these organisms, existing in the bottom of the ice and in the water just below the ice during spring (Horner et al. 1974). Responding to increased light, epontic populations develop in April, peak in May, and decline in June as the ice layer melts (Alexander et al. 1974).

3.5 Fish Resources

Major studies of fish distribution and abundance in the northeastern Chukchi Sea (Alverson and Wilimovsky 1966, Quast 1972, Frost and Lowry 1983, Fechhelm et al. 1984, and Barber et al. 1997) have documented the occurrence of more than 66 fish species in the northeastern Chukchi Sea.

Marine Fish

Both the number of species and fish biomass found in the northeastern Chukchi Sea are comparable to more southerly locations, but the diversity is much lower due to the predominance of arctic cod, which at many locations approaches or equals 100 percent of the fish fauna (Barber et al. 1997). Barber et al. (1994) identified six assemblages of demersal fish species; two of these encompass the survey area, Assemblage VI is predominant in the western / offshore portion of the survey area, and Assemblage III is predominant in the eastern and more coastal portions of the survey area. The most abundant species in both is the arctic cod; most other species were found in very low numbers (Table 3.5-1).

Table 3.5-1 Demersal Fish Species in Northeastern Chukchi Sea Fish Assemblages

Common Name [2]	Assemblage (fish/km^2) [1]					
	I	II	III	IV	V	VI
Arctic cod	43,733	16,419	5,280	8,172	16,096	6,100
Saffron cod	684	2	170	19	10,956	0
Sculpin	3,391	49	44	2	4,492	0
Staghorn sculpin	1,005	87	889	156	2,618	7
Bering flounder	1,599	72	0	61	15	3
Warty sculpin	178	0	429	177	773	9
Hamecon	20	0	0	11	1,061	4
Walleye pollock	69	0	0	26	861	0
Ribbed sculpin	70	3	120	59	722	0
Capelin	437	0	0	40	0	0
Wattled eelpout	453	0	0	139	323	0
Pacific herring	195	0	0	139	323	0
Slender eelblenny	235	18	2	14	141	0
Canadian eelpout	260	64	2	0	6	0
Marbled eelpout	76	7	4	284	13	5
Sturgeon poacher	60	0	18	5	280	0
Pacific cod	21	0	1	6	273	0
Variegated snailfish	129	2	0	15	29	0
Rainbow smelt	0	0	0	0	258	0
Butterfly sculpin	89	0	0	13	0	0
Hookear sculpin	80	0	0	0	20	0

[1] Source: Barber et al. 1994

[2] Includes only the 21 most abundant species

Arctic cod is an extremely important component of the Chukchi Sea ecosystem, often referred to as a keystone species due to its importance in the food chain (Frost and Lowry 1984, Lowry and Frost 1981). They spawn in January-February (Gillispie et al. 1997); eggs float in the water column (Dunn and Matarese 1984), developing/hatching under ice in May-June (Lowry et al. 1980). Larvae live in surface waters until August-September when they metamorphose into juveniles and descend to the seafloor.

Abundant pelagic species in northeastern Chukchi include Pacific herring and capelin (Craig 1984). Capelin are found in nearshore waters (Craig 1984, Fechhelm et al. 1984) within 2.5 mi (4 km) of the coast (Thorsteinson et al. 1991). They spawn in schools on smooth sand and gravel beaches (Jangaard 1974) in July-August near Barrow (Bendock 1977) and Kasegaluk Lagoon barrier islands (Fechhelm et al. 1984). Eggs are adhesive attaching to substrate (Jangaard 1974); larvae are pelagic.

Pacific herring are distributed at low densities throughout the Chukchi Sea (Hart 1983) but primarily in nearshore waters. Spawning grounds are located in high-energy nearshore environments with submerged vegetation, or rocks, spawning in the spring-early summer. They spawn in Kasegaluk Lagoon (Fechhelm et al. 1984). Eggs are demersal and adhesive attaching to vegetation, rocks, and other objects.

Diadromous Fish

Diadromous fish are not as abundant in the northeastern Chukchi Sea as in the southern Chukchi Sea or the Beaufort Sea (Craig 1984) and are largely restricted to nearshore waters (Craig 1984). Least cisco *Coregonus sardinella* and rainbow smelt *Osmerus mordax* are the principal species (Craig 1984) along with pink *Oncorhynchus gorbuscha* and chum salmon *Oncorhynchus keta*.

Other species present include Coho salmon *Oncorhynchus kisutch*, Chinook salmon *Oncorhynchus tshawytscha*, Sockeye salmon *Oncorhynchus nerka*, Arctic char *Salvelinus malma*, Arctic cisco *Coregonus autumnalis*, Bering cisco *Coregonus laurette*, broad whitefish Coregonus *nasus*, and humpback whitefish *Coregonus oidschian.*

Six streams supporting anadromous fish are located along the coast shoreward of the survey area, the Ivisaruk, Kuk, Kaoluk, Kungok, Mikigealik, and Kugrua Rivers (Johnson and Daigneault 2008). These rivers support spawning pink salmon. In the pink salmon two-year life cycle, juveniles travel to nearshore marine waters after hatching in freshwater. When they reach a length of 2.4-3.15 in. (6-8 cm), they move out to sea, spending 18 months there before returning to the stream to spawn (Mecklenburg et al. 2002). Reported runs in coastal Chukchi rivers have historically been estimated at less than 1,000 individuals.

Essential Fish Habitat (EFH)

EFH has been designated in the northeastern Chukchi Sea for Pacific salmon, arctic cod, saffron cod, and opilio crab. Marine EFH (MMS 2007b) for salmon includes all estuarine and marine areas used by Pacific salmon from the influence of tidewater to the limits of the U.S. Exclusive Economic Zone (EEZ). EFH (NPFMC 2000) for arctic cod and saffron cod (Table 3.5-2) encompasses Shell's survey area.

Table 3.5-2 EFH for Arctic Cod, Saffron Cod, and Opilio Crab in the Chukchi Sea

Species	Eggs	Early Juvenile	Late Juvenile [1]	Adult [1]
Arctic cod	-	-	Pelagic/epipelagic 0-656 ft (0-200 m) often with ice floes	Pelagic/epipelagic 0-656 ft (0-200 m)
Saffron cod	-	-	Pelagic/epipelagic 0-164 ft (0-50 m) with substrates of sand & gravel	Pelagic/epipelagic 0-164 ft (0-50 m) with substrates of sand & gravel
Opilio crab	Inferred [2]	-	Pelagic/epipelagic 0-328 ft (0-100 m) south of Cape Lisburne with mud substrate	Pelagic/epipelagic 0-328 ft (0-100 m) south of Cape Lisburne with mud substrate

[1] EFH includes suitable habitat for these life stages within the stated geographic area
[2] Inferred from egg-bearing females – same as adult

3.6 Coastal and Marine Birds

Most of the birds that use the Chukchi Sea are migrants, using coastal areas for breeding and nesting. Spring migration for some birds starts with the ice lead openings; many birds follow open leads that form along the landfast ice edge. Nearly all species are seasonal residents from May through September with most birds migrating south by late fall before the formation of sea ice.

USFWS (2000) has identified 34 seabird nesting colonies along the northeastern Chukchi Sea; four of these are located shoreward of the survey area. A colony at Icy Cape contained about 70 common eiders, glaucous gulls, and arctic terns. A colony at Akoliakatat Pass contained about 494 birds of the same species. Two small colonies at Peard Bay contained about 54 arctic terns and horned puffins.

Cliff-Nesting Birds

Cliff-nesting species that nest along the coastline of the northeastern Chukchi Sea or are commonly found in offshore waters are listed in Table 3.6-1. Large numbers of cliff-nesting birds are found in cliff colonies around Cape Lisburne where over 200,000 murres and 18,000 kittiwakes nest. Other species such as the auklets do nest along the northeastern Chukchi Sea but use offshore waters in great numbers.

Table 3.6-1 Cliff-Nesting Seabirds Found in the Northeastern Chukchi Sea

Common Name	Scientific Name	Status in NE Chukchi Sea
Common murre	*Uria aalge*	Arrive in April, depart colonies by late September, leave Chukchi by late October
Thick-billed murre	*Uria lomvia*	
Black guillemot	*Cepphus grylle*	Migrate into Chukchi in spring lead system, nest June-July, fledge early September, leave Chukchi with advancing ice
Tufted puffin	*Fratercula cirrhata*	Arrive in early June, leave colonies by 2 October, regular in Chukchi Sea in August, more abundant in September
Horned puffin	*Fratercula corniculata*	
Parakeet auklet	*Aethia psittacula*	Do not nest here but nonbreeders use offshore waters August-September, departing by late October
Least auklet	*Aethia pusilla*	
Crested auklet	*Aethia cristatella*	
Black-legged kittiwake	*Rissa tridactyla*	Migrate into Chukchi in spring leads arriving colonies in May, colonies depleted by mid-October, colony members forage out 75 m from Cape Lisburne, nonbreeders use all offshore water
Short-tailed shearwater	*Puffinus tenuirostris*	Breed in southern hemisphere, found in Chukchi May-November but most gone by late September
Northern fulmar	*Fulmarus glacialis*	Truly pelagic species coming to shore only to nest, most stay in Bering but nonbreeders use Chukchi Sea each year
Pelagic cormorant	*Phalacrocorax pelagicus*	Winter in Bering/Gulf of Alaska, arrive coastal waters of Chukchi in May and depart in October, few use Chukchi waters north of Ledyard Bay

[1] Kittlitz's murrelet (Brachyramphus brevirostris) discussed under threatened and endangered species

Gull, Terns, and Jaegers

Gull, tern, and jaeger species that commonly use the survey area are listed in Table 3.6-2.

Table 3.6-2 Gulls, Terns, and Jaegers in the Northeastern Chukchi Sea

Common Name	Scientific Name	Status in NE Chukchi Sea
Glaucous gull [1]	*Larus hyperboreus*	Winter in North Pacific but few overwinter in NE Chukchi Sea, migrants in April following spring leads, nest in mid-June to early July, fledging complete by late August, large influx of non-breeders late summer. Most fall migration occurs along coast in September / October, but many present as late as early December.
Ivory gull	*Pagophila eburnea*	Associated with ice, even in winter when at ice front in the Bering, in summer is restricted to the Arctic Basin. Does not nest along NE Chukchi Sea, but non-breeders found in offshore waters throughout seldom near land, rare in summer, becoming common or abundant late September and October where there is pack ice.
Ross's gull	*Rhodostethia rosea*	Winter range not known but may be present in arctic waters throughout winter. Larger numbers enter the Chukchi Sea after mid-August to feed; often in nearshore waters in the fall between Wainwright and Barrow, common in offshore waters, in late September and October. Does not nest in Alaska Most of the world population aggregate near Barrow each fall prior to migration
Sabine's gull	*Xema sabini*	Nests on the shores or islands of tundra lakes and on barrier islands, uses coastal waters during migration with most observations occurring landward of the 66 ft (20 m) isobaths, but also in low numbers offshore

Table 3.6-2 Gulls, Terns, and Jaegers in the Northeastern Chukchi Sea

Common Name	Scientific Name	Status in NE Chukchi Sea
Arctic tern	*Sterna paradisaea*	Arrives in Chukchi Sea in May peaking mid-June. Nests in small colonies on islands and spits in late June or early July. Primarily use coastal waters with most observations within 25 mi (40 km) of shore. Fall migration is abrupt and coastal - most departed by mid-September; winter in Southern Hemisphere near Antarctica
Pomarine jaeger	*Stercorarius pomerinus*	Spend most of life at sea, to land only to nest. Winter at sea in the Southern Hemisphere. Migrate into Chukchi Sea across broad front over land & sea arrives late May-early July. Nests on tundra. Non-breederss found in offshore waters, commonly along ice front. Fall migration begins late August, complete by late September.
Parasitic jaeger	*Stercorarius parasiticus*	
Long-tailed jaeger	*Stercorarius longicaudus*	

[1] Black-legged kittiwakes are cliff-nesting gulls and are discussed in Section 3.6.1.

Loons

Loon species found in the survey area and adjacent coastal habitats include Pacific loons (*Gavia pacifica*), red-throated loons (*G. stellata*), and yellow-billed loons (*G. adamsii*). Spring migration in and along the Chukchi Sea begins in late May-early June peaking in late June (Roseneau and Herter 1984). Migration is concentrated in the spring lead system where large numbers have been observed resting (Roseneau and Herter 1984). They then disperse to nest sites at low densities across the Arctic Coastal Plain. The red-throated loon is more closely associated with the marine environment than other loons (Larned et al. 2007), and is the only loon that feeds their young almost exclusively on marine species (Schmutz 2008). Eggs are deposited in June and incubated for about a month; the young leave the nest within 1-2 days and in September migrate to coastal waters where non-breeding birds tend to remain. They are common and regular along the Chukchi Sea coastline (Lysne et al. 2004; Dau and Larned 2006, 2007, 2008). Fall migration begins in late August, peaking in September, but continuing through October (Watson and Divoky 1972).

Waterfowl

Species of waterfowl commonly found in marine habitats of the northeastern Chukchi Sea and adjacent coastal areas are listed in Table 3.6-3. Additonal information on the most abundant species in offshore waters is provided below.

Table 3.6-3 Common Waterfowl in the Northeastern Chukchi Sea

Common Name	Scientific Name
Red-breasted merganser	*Mergus serrator*
Northern pintail	*Anas acuta*
Greater scaup	*Aythya marila*
Black scoter	*Melanitta nigra*
White-winged scoter	*Melanitta fusca*
Long-tailed duck	*Clangula hyemalis*
Common eider	*Somateria mollissima*
King eider	*Somateria spectabilis*
Lesser snow goose	*Chen caerulescens*
Greater white-fronted goose	*Anser albifrons*
Canada goose	*Branta canadensis*
Pacific black brant	*Branta bernicula nigricans*
Tundra swan	*Cygnus columbianus*

[1] Spectacled and Steller's eiders are discussed as threatened and endangered species.

Long-tailed ducks from the North Slope winter in ice-free waters of the Sea of Japan and Sea of Okhotsk in Asia (Sea Duck Joint Venture 2003, USGS 2008). At least several hundred thousand migrate into or through the northeastern Chukchi Sea, with spring migration commencing along the lead system in mid-May and continuing through June (Roseneau and Herter 1984). They nest across the North Slope and after fledging move to marine habitats where the female undergoes a molt during which she is flightless. Males and non-breeding females move to molting areas sooner. Molting takes place in lagoons and other shallow waters, through July and August, after which they utilize coastal waters to feed and stage for fall migration. Known molting areas include Peard Bay, Kasegaluk Lagoon, and Ledyard Bay. Fall migration begins in early September, with few long-tailed ducks remaining in the area after mid-October (Roseneau and Herter 1984). Fall migration is concentrated, with the birds forming large flocks. Lehnhausen and Quinlan (1981) estimated that 186,000 long-tailed ducks migrated past Icy Cape between 22 August and 20 September 1981. Survey data indicate that the U.S. and Canadian breeding population of long-tailed ducks has declined by about 80 percent since 1957; however, the population seems to have stabilized since the 1990s (Sea Duck Venture 2003). Over the past 20 years (1992-2007) the North Slope population has been stable (Larned et al. 2012).

King eiders that nest in Alaska winter in the Bering Sea, Bristol Bay and the Gulf of Alaska, and the Sea of Okhotsk. They migrate to and through the Chukchi Sea following the spring lead system, reaching the northeastern Chukchi Sea by mid-May, but sometimes as early as April (Roseneau and Herter 1984). As many as a million king eiders may transit through the Chukchi at this time (Woodby and Divoky 1982). A relatively small proportion of this population remains in the northeastern Chukchi Sea or nests along the coastline. They nest on the tundra near lakeshores (Powell et al. 2005). Eggs are laid mid-June to mid-August, and hatch mid-July to early August (Roseneau and Herter 1984). The males depart these nesting areas at the on-set of incubation and migrate to molting areas; breeding females and their young move to the sea when they fledge. Primary molting areas are located along the Chukotka Peninsula in Russia (Sea Duck Venture 2004a) but molting also occurs in Peard Bay, northern Kasegaluk Lagoon. The molt migration occurs through the Chukchi Sea starting in early July with the males, and increasing in August with the females (Roseneau and Herter 1984). At this time king eiders are found in nearshore and offshore waters of the northeastern Chukchi Sea. Springer et al. (1982) estimated that 50,000 eiders passed Cape Lisburne each day in late July of 1980. These large scale movements continue until early October and some birds remain as long as there is open water, sometimes as late as mid-November (Bailey 1948). Divoky (1987) reported that eiders were common along the 66 ft (20 m) depth contour, where migration is concentrated, through the summer, but small numbers were observed much further offshore after 22 September. The population of king eiders has dramatically declined in recent times: from 1953 to 1976 the population appeared to be stable but declined by 56 percent from approximately 802,556 birds in 1976 to about 350,835 birds in 1996 (Suydam et al. 2000).

Most common eiders from North Slope winter in the Bering Sea and Sea of Okhotsk (USGS 2009). They migrate to and through the Chukchi Sea following the spring lead system, reaching the northeastern Chukchi Sea by mid-May. A relatively small proportion of this population remains in the Chukchi Sea or nests along the coastline; most nest along the Beaufort Sea and arctic Canada. Females typically return to their natal areas and reuse the same nest site (Sea Duck Venture 2004b), nesting in dense colonies along the coast on sand spits and barrier islands. Eggs (3-4 per nest) are laid May or June, hatching 24-26 days later (Sea Duck Venture 2004b).

Young are reared in marine waters near nesting sites, are fledged in 60-65 days. Most males and non-breeding females migrate to molting sites in June-July; breeding females follow in August-September (Sea Duck Venture 2004b). Females molt in coastal waters near the nesting colonies (Peterson and Flint 2002). In the Chukchi, common eiders molt in areas near Point Lay, Icy Cape, and Cape Lisburne (Johnson and Herter 1989); Peard Bay may also be particularly important to molting common eiders (Kinney 1985). They are flightless during this 3-4 week molting period. After molting and staging, they begin fall migration to wintering areas. Migration is concentrated along the 66 ft (20 m) depth contour where they are common in the summer, but small numbers were observed much further offshore after 22 September (Divoky 1987). Large scale movements through the northeastern Chukchi Sea occur through October, with some remaining as late as mid-November (Bailey 1948). The common eider population declined dramatically by 53 percent from approximately 156,081 in 1976 to about 72,606 in 1996 (Suydam et al. 2000). No annual breeding waterfoul surveys indicate a stable North Slope King eider population from 1992-2011 (Larned et al. 2012).

Shorebirds

Troy (2000) listed 16 shorebird species that routinely use the North Slope and another 20 that occur as migrants, vagrants, or rare breeders (Troy 2000). A 1998-2004 North Slope-wide study (Johnson et al. 2007) of the distribution of shorebirds documented a total of 19 species breeding in the area. Generally, shorebirds are present on the North Slope from May to mid-August. These species nest on the tundra, but many move to the Chukchi Sea coastline to use intertidal habitats for feeding and staging prior to and during migration (Johnson and Herter 1989). The most common shorebird species breeding on the North Slope are dunlin, semipalmated sandpiper, pectoral sandpiper, and red phalarope (Alaska Shorebird Working Group 2008). Kasegaluk Lagoon and Peard Bay have been identified as two of the most important shorebird sites in the U.S. (Brown et al. 2001).

Only two species, the red phalarope and red-necked phalarope routinely use offshore waters of the survey area. They spend most of their life in pelagic waters off the coasts of South America and Africa. Red-necked phalaropes breed throughout Alaska, wherever there is suitable habitat. Red phalaropes nest in coastal areas of Alaska from the Y-K Delta north to the Canadian boundary. Both species migrate into the area in late May - early June (Lehnhausen and Quinlan 1981). Use of shoreline habitats at this time is light (Roseneau and Herter 1984); however, large numbers of migrating and staging phalaropes use the shoreline and nearshore waters in July-September, gathering in large concentrations in lagoons. Fall and spring migration for red phalaropes occurs along routes well out at sea where flocks concentrate at ice edges and oceanic fronts where invertebrate prey is plentiful (Johnson and Herter 1989).

Bird Use of Offshore Waters

Extensive bird surveys were conducted by Divoky (1987) in the northeastern Chukchi Sea, densities of birds observed in the central northeastern Chukchi Sea are provided in Table 3.6-4.

Table 3.6-4 Bird Densities for the Central Northeastern Chukchi Sea

Species	16 July - 22 August (birds/km^2) [1]		24 August - 22 September (birds/km^2) [1]		22 September - 17 October (birds/km^2) [1]	
	Mean	Maximum	Mean	Maximum	Mean	Maximum
Loons	0.1	3.7	0.3	4.4	0.5	9.5
Northern fulmar	<0.1	1.8	0.2	1.4	0.0	0.0
Shearwaters	0.0	0.0	5.4	221.4	0.3	6.6
Eiders	1.8	120.0	2.1	131.1	4.3	270.0
Long-tailed ducks	<0.1	10.8	0.2	12.4	11.6	730.0
Phalaropes	1.0	125.0	1.9	49.3	0.2	24.0
Jaegers	0.7	21.6	0.5	10.8	0.1	4.5
Glaucous gull	0.5	21.6	0.3	10.8	0.7	13.6
Ivory gull	<0.1	0.8	0.0	0.0	0.9	35.0
Black-legged kittiwake	1.5	28.6	2.2	43.7	0.3	9.0
Ross's gull	<0.1	1.6	0.0	0.0	2.9	120.0
Murres	2.3	59.3	0.6	4.1	0.2	10.0
Black guillemot	0.5	12.8	<0.1	1.2	1.2	35.0
Kittlitz's murrelet	<0.1	0.7	<0.1	2.2	0.1	8.1
Parakeet auklet	<0.1	0.5	0.1	2.8	<0.1	0.5
Least auklet	0.0	0.8	0.3	8.3	<0.1	0.7
Crested auklet	0.0	0.0	5.2	126.0	0.7	90.0
Tufted puffin	<0.1	2.2	<0.1	0.5	0.0	0.0
Horned puffin	<0.1	0.0	<0.1	0.0	0.2	39.2
Unidentified small alcid	0.01	3.3	0.47	13.3	0.04	1.8
Total Birds	8.9	246.0	19.9	237.6	27.6	870.6

[1] Source: Divoky 1987; densities re for the central part of the northeastern Chukchi Sea (north of Cape Lisburne)

A total of 31 species were observed in 2008, and 23 in 2009, during bird surveys at the Burger Prospect in the northeastern part of the survey area (Gall and Day 2009, 2010). Eight were detected enough to generate reliable estimates of density (Tables 3.6-5, 3.6-6). Other species were uncommon or rare.

Table 3.6-5 Densities of Common Species in the Burger Prospect Area in 2008

Species-group/species [1]	Year	Season Observed [2,3]		
		Late Summer	Early Fall	Late Fall
Pacific Loon	2008	0.0 (0)	0.1 (0.1-0.3)	<0.1 (<0.1-<0.1)
	2009	0.0 (0)	1.1 (0.8-1.5)	<0.1 (<0.1-<0.1)
Northern Fulmar	2008	<0.1 (<0.1-0.1)	0.1 (<0.1-0.1)	0.1 (<0.1-0.1)
	2009	1.2 (0.8-1.8)	0.2 (0.2-0.4)	0.2 (0.1-0.3)
Short-tailed Shearwater	2008	0.0 (0)	0.8 (0.5-1.5)	0.3 (0.2-0.6)
	2009	1.3 (0.4-3.8)	1.7 (1.3-2.2)	0.3 (0.2-0.5)
Black-legged Kittiwake	2008	0.1 (0.1-0.2)	0.8 (0.6-1.0)	0.1 (0.1-0.3)
	2009	0.1 (0.1-0.3)	2.0 (1.5-2.6)	0.2 (0.1-0.3)
Glaucous Gull	2008	<0.1 (<0.1-0.1)	0.2 (0.1-0.3)	0.1 (0.1-0.2)
	2009	<0.1 (<0.1-0.1)	0.4 (0.3-0.5)	0.3 (0.2-0.5)
Thick-billed Murre	2008	<0.1 (<0.1-0.1)	0.0 (0)	<0.1 (<0.1-<0.1)
	2009	0.1 (0.1-0.1)	0.1 (<0.1-0.4)	0.1 (<0.1-0.2)
Least Auklet	2008	0 (0)	<0.1 (<0.1-<0.1)	<0.1 (<0.1-0.1)
	2009	1.7 (1.1-2.7)	1.1 (0.9-1.5)	0.4 (0.2-0.6)
Crested Auklet	2008	0 (0)	<0.1 (<0.1-<0.1)	0.2 (0.1-0.4)
	2009	34.5 (29.2-40.8)	37.7 (29.1-48.7)	0.1 (0.1-0.2)
TOTAL BIRDS	2008	0.3 (0.2-0.5)	2.7 (2.1-3.5)	2.3 (1.7-3.0)
	2009	40.8 (35.1-47.4)	45.9 (37.1-56.8)	2.2 (1.8-2.6)

[1] Includes only those groups observed frequently enough for reliable density estimates
[1] Source: Gall and Day 2009, 2010, boat-based surveys
[3] Values in parentheses are 95% confidence intervals.

Table 3.6-6 Seabird Species Composition in the Burger Prospect Area in 2008 and 2009

Bird Species Group	Percent of Observed Birds [1]							
	Late Summer		Early Fall		Late Fall		Open Water	
	2008	2009	2008	2009	2008	2009	2008	2009
Waterfowl	0	0	14	1	2	1	9	<1
Loons	0	0	7	4	1	<1	4	2
Tubenoses	15	7	38	**6**	19	25	30	7
Phalaropes	0	5	11	3	0	3	7	4
Larids	65	1	30	5	51	40	39	4
Alcids	20	87	0	82	28	30	11	82
All	100	100	100	100	100	100	100	100

[1] Source: Gall and Day 2010, boat-based surveys

3.7 Marine Mammals

Fifteen marine mammals could be found in the survey area (Table 3.7.1). Of these, three are listed as endangered, one is threatened, two have Distinct Population Segment (DPS's) that are listed as threatened, and one is proposed for ESA listing. These species are further discussed in Section 3.8.

Table 3.7-1 Marine Mammals in the Northeastern Chukchi Sea

Common Name	Scientific Name	ESA Status	MMPA Stock Status	Extralimital (Yes/No)
Ringed seal	*Phoca hispida*	threatened	Not depleted	No
Spotted seal	*Phoca largha*	Not listed	Not depleted	No
Ribbon seal	*Phoca fasciata*	Not listed	Not depleted	No
Bearded seal	*Erignathus barbatus*	Threatened	Not depleted	No
Pacific walrus	*Odobenus rosmarus divergens*	Candidate	Not depleted	No
Polar bear	*Ursus maritimus*	Threatened	Depleted	No
Bowhead whale	*Balaena mysticetus*	Endangered	Depleted	No
Gray whale	*Eshchrichtius robustus*	Not Listed	Not depleted	No
Fin whale	*Balaenoptera physalus*	Endangered	Depleted	Yes
Minke whale	*Balaenoptera acutorostrata*	Not listed	Not depleted	No
Humpback whale	*Megaptera novaengliae*	Endangered	Depleted	Yes
Killer whale	*Orcinus orca*	Not listed	Not depleted	Yes
Harbor porpoise	*Phocoena phocoena*	Not listed	Not depleted	No
Beluga whale	*Delphinapterus leucas*	Not listed	Not depleted	No
Narwhal	*Monodon monoceros*	Not listed	Not depleted	Yes

Further details on the species and the status by stock can be found in the National Oceanic and Atmospheris Administration (NOAA) Alaska and Pacific U.S. Stock Assessment Reports (Allen and Angliss 2012) and the EIA (Shell 2011b) for Shell's Revised Chukchi Sea EP (Shell 2011a). Shell and industry partners have conducted marine mammal mitigation/monitoring efforts for past oil and gas exploration activities in the Chukchi Sea (Funk et al. 2007, 2008, 2009, 2010, 2011a, 2011b; Ireland 2007, 2009a,b; Patterson et al. 2007; Reiser et al. 2010, 2011) and these documents provide additional information on marine mammal sightings, densities, and exposures to industrial activities. NOAA's National Marine Mammal Laboratory (NMML) has conducted marine mammal surveys (Clarke et al. 2011, 2012) and directed research programs in the Chukchi Sea in recent years and those data can be found in reports to both NOAA and BOEM. Density estimates for the survey area will be calculated from these data sources and will be included in the IHA request to NMFS.

3.8 Threatened and Endangered Species and Critical Habitat

Species listed as threatened, endangered, or candidate species under the Endangered Species Act (ESA) that may occur in the survey area are listed below in Table 3.8-1.

Table 3.8-1 Threatened or Endangered Species in the Chukchi Sea

Common Name	Scientific Name	ESA Status	Extralimital (Yes/No)
Spectacled eider	*Somateria fischeri*	Threatened	No
Steller's eider	*Polysticta stelleri*	Threatened	No
Kittlitz's murrelet	*Brachyramphus brevirostris*	Candidate	No
Yellow-billed loon	*Gavia adamsii*	Candidate	No
Ringed seal	*Phoca hispida*	Threatened	No

Bearded seal	*Erignathus barbatus*	Threatened	No
Pacific walrus	*Odobenus rosmarus divergens*	Candidate	No
Polar bear	*Ursus maritimus*	Threatened	No
Bowhead whale	*Balaena mysticetus*	Endangered	No
Fin whale	*Balaenoptera physalus*	Endangered	Yes
Humpback whale	*Megaptera novaeangliae*	Endangered	Yes

Spectacled Eider

The spectacled eider is listed as a threatened species. Currently the breeding distribution of the spectacled eider includes the central coast of the Yukon-Kuskokwim (Y-K) Delta, the Arctic Coastal Plain of Alaska, and the Arctic Coastal Plain of Russia (USFWS 2005, 2007). Densities of spectacled eiders vary across the North Slope along the Chukchi Sea coast, with the area from Dease Inlet south and west to Wainwright containing some of the highest densities on the North Slope (Larned et al. 2005). The spectacled eider population is currently estimated to be about 360,000 worldwide, (USFWS 2007). Spectacled eider numbers on the North Slope counted during annual aerial surveys has indicated a relatively stable population with an estimated 2011 population of 7,952 from 1992-2011 (Larned et al. 2012).

After nesting, spectacled eiders move to coastal waters where they migrate to molting areas. Males move to the marine environment by mid-to-late June (Troy 2003), followed by females that are unsuccessful nesters in mid-to-late July. Successful females and their broods move to coastal waters between 26 August and 4 September (Petersen et al. 1999). Breeding males leave the nesting grounds for the marine environment by mid- to late June (Larned et al. 2012), and adults congregate to molt in large flocks along the coast during late summer (MMS 2006b).

The summer distribution of non-breeding eiders is not well known, but they are thought to be present in small flocks in coastal waters, including the Chukchi Sea (USFWS 2002). Small numbers are observed in nearshore waters along the Chukchi coastline during annual USFWS waterbird surveys (Dau and Larned 2006, 2007, 2008). Molting flocks gather in shallow coastal waters up to 120 ft (65 m) deep. There are three principal molting areas, Mechigmensky Bay in Russia, Norton Sound, and Ledyard Bay in the Chukchi Sea (Peterson et al. 1999) where as many as 33,000 spectacled eiders molt (Larned et al. 1995). All marine waters greater than 16.4 ft (5.0 m) deep and less than 82 ft (25 m) in Ledyard Bay have been designated critical habitat for the species (Figure 1.0-1). Other important molting and staging areas in the Chukchi Sea include Peard Bay and Kasegaluk Lagoon (Petersen et al. 1999). In winter, most of the world's population of spectacled eiders winters south of St. Lawrence Island in the Bering Sea, where they forage in open leads (USFWS 2002, 2007).

Divoky (1987) reported that eiders (including spectacled eiders) were commonly observed along the 20 m isobath of the northeastern Chukchi Sea during the summer but only after 22 September did they move to more offshore waters; even then they were much more common in nearshore waters. One was observed during two years of intensive surveys in the area of Shell's Burger Prospect in the northeast corner of the survey area (Gall and Day 2009).

Steller's Eiders

The Alaska breeding population of the Steller's eider is listed as a threatened species, due to an apparent long-term decline in numbers and a restriction in breeding range (USFWS 2007). Causes of the decline are unknown but may include increased predation pressure on the breeding grounds, subsistence harvest, ingestion of lead shot, and contaminants (Henry et al. 1995).

Bustnes and Systad (2001) suggested that Steller's eiders might have specialized feeding behaviors that limit the availability of winter foraging habitat, so that they could be affected by climate regime shifts that cause changes in prey communities. The Alaska-breeding population is primarily confined to the Arctic Coastal Plain in low densities; they are extremely scarce in western Alaska (USFWS 2007). The Alaska-breeding population is thought to be in the hundreds or low thousands on the Arctic Coastal Plain and in the dozens on the Y-K Delta (USFWS 2007). Steller's eider numbers have declined since the 1960s (Kertell 1991 cited in MMS 2006b) and appear to still be declining since 1992 (Larned 2007). A low density (0.10/mi^2 [0.04/km^2]) of Steller's eiders was documented using Kasegaluk Lagoon in 1991, but not in 1989 and 1990 (Johnson et al. 1993). No critical habitat areas have been designated on the North Slope or in the Chukchi Sea, but the North Slope is used for nesting, particularly in the Barrow area (USFWS 2007).

Steller's eiders arrive on the nesting areas in Alaska as early as 5 June (Bent 1987 cited in MMS 2006b). Nesting sites are on coastal wetland tundra or shallow ponds and lakes well inland (MMS 2006b). Steller's eiders leave Barrow nesting area in late June and move to coastal waters between Wainwright and Dease Inlet and between Cape Lisburne and Point Lay (MMS 2006b). Steller's eiders are diving ducks that spend most of their time in shallow marine waters where they can reach mollusks and crustaceans (USFWS 2007). Their use of offshore portions of the survey area is probably light to non-existent; none were observed during intensive surveys conducted around the Burger Prospect in 2008 and 2009 (Gall and Day 2010).

Kittlitz's Murrelet

The Kittlitz's murrelet was designated a candidate species in 2004 because numbers have declined sharply and therefore may warrant listing as a threatened or endangered species (USFWS 2007). Glacial retreat and cyclical changes in the oceanic environment are strongly suspected as reasons for the declining Kittlitz's murrelet population (Day et al. 2000, USFWS 2004, MMS 2006b) as glacial areas are important habitat for this species (Day et al. 2000). In 2010, USFWS (2010d) concluded that earlier estimates may have been biased low and provided a current world-wide estimate of the world-wide population at 30,900 - 56,800 individuals, with perhaps 11,100 being outside of the U.S. in Russia. The Center for Biological Diversity estimated the population along the Chukchi Sea coastline (including Wrangel Island) at 450 in 1993 (Van Vliet and McAllister 1994 in CBD 2001).

Kittlitz's murrelet distribution is clumped during the breeding season. In the Chukchi Sea, they are found most commonly along the northern Seward Peninsula and in the Cape Lisburne area (MMS 2006b). They nest on scree mountain slopes. Nests have been found at the end of the Delong Mountains near Cape Thompson (USFWS 2009) and these birds may nest as far north as Cape Beaufort between Cape Lisburne and Point Lay (USFWS 2009, CBD 2001). Little is known about the Kittlitz's murrelet reproductive strategy (MMS 2006b). They appear to be paired upon arrival to breeding grounds and egg-laying occurs from mid-May to mid-June. Fledging in northern populations generally occurs during August (MMS 2006b). Their winter distribution is not well known but they are thought to move south with the advancing ice and winter in pelagic waters over the continental shelf in the Bering Sea and Gulf of Alaska.

Kittlitz's murrelets have been found to have a pelagic distribution from approximately 13-132 mi (21-213 km) offshore (Divoky 1987). Divoky (1987) reported that the Kittlitz's murrelet is rare in pelagic waters of the Chukchi Sea until late August when it becomes regular but uncommon. He provided an estimated average density of <26 birds/100 mi^2 (<10 birds/100 km^2) and a

maximum density of 57 birds/100 mi^2 (22 birds/100 km^2) in the central northeastern Chukchi Sea (including the survey area) in late August and September, decreasing in October. The furthest offshore distance recorded in the Chukchi Sea was during the 22 August to September survey period (Divoky 1987). Divoky estimated that 15,000 Kittlitz's murrelets are typically present in the Chukchi Sea in early fall. No Kittlitz's murrelets were observed in the Burger Prospect area in 2008 but a group of six were recorded in the Burger Prospect area in late fall 2009 (Gall and Day 2010). These data indicate that Kittlitz's murrelet could occur in small numbers in the survey area during the planned survey program.

Yellow-billed Loon

In March 2009, the USFWS determined that listing the yellow-billed loon as a threatened or endangered species range-wide is warranted under the ESA, but also that listing is precluded by other higher priority species. It is therefore considered a candidate species under the ESA. The density of breeding yellow-billed loons varies across the Arctic Coastal Plain, with medium low densities occurring in coastal lands along the northeastern Chukchi Sea. Approximately 3,369 individuals use the breeding grounds on the North Slope, with most occurring within the National Petroleum Reserve-Alaska (Earnst et al. 2005). In addition, approximately 1,500 individuals, most likely adult non-breeders and juveniles, remain at sea. In total, there are an estimated 4,892 yellow-billed loons on the North Slope breeding grounds and at sea (Earnst et al. 2005). There is no evidence of a long-term trend in the breeding population of yellow-billed loons on the Arctic Coastal Plain over the last 18 years (Earnst 2004). Earnst (2004) reported estimates of the density of nesting yellow-billed loons on the North Slope coastal plain of about 0.01/mi^2 (0.027-0.033 loons/km^2).

Yellow-billed loon migration routes are thought to be marine. Open water leads and polynyas are known to be important for staging and spring migration (Searing et al. 1975).They arrive along the Chukchi Sea coast in early May and leave at the end of August to mid-September (Johnson and Herter 1989). Yellow-billed loons prefer large, deep, tundra lakes where they nest on low islands or near the edges of lakes to avoid terrestrial predators (Johnson and Herter 1989). On the North Slope, nesting begins as early as mid-June (Johnson and Herter 1989). Foraging habitats in the breeding season include lakes, rivers, and the nearshore marine environment (Earnst 2004). They winter in ice-free marine waters primarily from southern Alaska through British Columbia and off the coast of Norway, Kamchatka Peninsula, Japan, North Korea, and China (Earnst 2004) with most yellow-billed loons from the North Slope wintering off North Korea, Japan, and China (Schmutz 2009).

Yellow-billed loons are found in the northeastern Chukchi Sea. Aerial bird surveys conducted by the USFWS (Fischer et al. 2002, Lysne et al. 2004) have noted that nearshore areas are relatively more important to yellow-billed loons. Lysne et al. (2004) reported 43 observations of yellow-billed loons along the Chukchi Sea coast west of Barrow over four years of surveying. The majority of these observations (86 percent) occurred between Barrow and Peard Bay. They are however, found in offshore waters as well. A total of 3 yellow-billed loons were observed in the Burger Prospect area in early fall 2008, and 48 were observed in early-late fall 2009 (Gall and Day 2010). Small numbers of yellow-billed loons would be expected to occur in the survey area during the survey.

Polar Bears

Polar bears are ESA listed as threatened and are protected under MMPA and by international treaties. Congress passed the United States-Russia Polar Bear Conservation and Management Act of 2006. The Alaskan polar bear population is considered to consist of two stocks, the Chukchi/Bering Sea stock and the southern Beaufort Sea stock, although there is overlap between Point Hope and Point Barrow (Amstrup 1995, Amstrup et al. 2005). In 2001, the southern Beaufort Sea stock was estimated at 2,200 bears (USFWS 2010c). There is no reliable estimate for the Chukchi/Bering Sea stock, but probably contains at least 2,000 animals (Aars et al. 2006, USFWS 2010b). USFWS (2010e) designated critical habitat for the polar bear over much of the Chukchi Sea; however, that decision was vacated and remanded back to the agency by the courts on 6 January 2013.

Bowhead Whales

Bowhead whales are listed as depleted under the MMPA and endangered under the ESA, throughout their range. Only the Western Arctic stock occurs in U.S. waters. The majority of these whales winter in the central and northwestern Bering Sea (November to March), migrate through the Chukchi Sea in the spring (March to June) following offshore ice leads, and summer in the Canadian Beaufort Sea (mid-May through September). In the fall bowheads migrate westward along the U.S. Beaufort Sea coast across the Chukchi Sea to Russian waters and then south through the Bering Strait to the Bering Sea. (Braham et al. 1980, Moore and Reeves 1993). The most current (2004) population estimate for the Western Arctic stock is 12,631 and increasing at a rate of 3.2% - 3.4% annually (Allen and Angliss, 2012); however, assuming population growth continues at this rate, the 2013 bowhead population may number around 15,740 animals.

Fin Whales

Fin whales are listed as depleted under the MMPA and endangered under the ESA, throughout their range. Of the three designated stocks, animals from the Northeast Pacific (Alaska) stock may occur in the Chukchi Sea. Reliable estimates of current and historical abundance of fin whales in the entire northeast Pacific are currently not available. Based on surveys which covered only a small portion of the range of this stock, a rough minimum estimate of the size of the population west of the Kenai Peninsula is 5,700. Data suggests that this stock may be increasing at an annual rate of 4.8 percent; however, this is based on uncertain population size and incomplete surveys of its range (Allen and Angliss, 2012). The northeastern Chukchi Sea is outside of published range maps (Allen and Angliss 2012), but a few fin whales have recently been observed in the Chukchi Sea (Funk et al. 2011b).

Humpback Whales

Humpback whales are listed as depleted under the MMPA and endangered under the ESA, throughout their range. Three management stocks of humpback whales are recognized within the North Pacific: the eastern North Pacific stock, the central North Pacific stock, and the western North Pacific stock. Population estimates for the entire North Pacific are estimated to be just fewer than 20,000 animals (Calambokidis et al. 2008). The population is estimated to be growing six to seven percent annually (Allen and Angliss, 2012). The northeastern Chukchi Sea is outside of published range maps (Allen and Angliss 2012), but a few humpback whales have recently been observed in the Chukchi Sea (Funk et al. 2011b).

Ringed Seals

Effective February 26, 2013, four subspecies of ringed seals are listed under ESA and therefore depleted under the MMPA. The Arctic (*Phoca hispida hispida*) subspecies, which occurs in the Chukchi Sea, is listed as threatened. Reliable population estimates and growth trends for this stock are currently unavailable, but Allen and Angliss (2011) reported that a minimum of 249,000 ringed seals are probably found in the Chukchi and Beaufort Seas where they are common throughout the year.

Bearded Seals

Effective February 26, 2013 the Beringia distinct population segment (DPS) of bearded seals occurs in the Chukchi Sea is listed as threatened under the ESA and therefore depleted under the MMPA. Reliable population estimates and growth trends for this stock are currently unavailable (Allen and Angliss, 2012). Earlier estimates of the Chukchi and Beaufort Sea population of bearded seals have ranged from 250,000 to 300,000 animals (Burns 1981). Their occurrence is common and regular in the Chukchi Sea, including the survey area.

Pacific Walrus

On 10 February 2011 (FR Vol 76 No 28:7634-7679) the USFWS announced a 12-month finding in which they found that listing of the Pacific walrus (but not the Atlantic walrus) as a threatened or endangered species was warranted, but was precluded by higher priority actions, giving them candidate species status under the ESA. Pacific walrus are found throughout the continental shelf waters of the Bering and Chukchi Seas, and they occasionally move into the East Siberian and Beaufort Seas. Walrus, particularly females and calves, are often found moving with the pack ice year-round. In the winter, they are found in the Bering Sea, and in the summer, they are found throughout the Chukchi Sea (USFWS 2010a). However, their range varies with the extent of sea ice.

Spring migration into the Chukchi usually begins in April, with most walrus moving north through the Bering Strait by late June. Most early spring migrants are females with calves. During migration, walrus exhibit gender segregation (Fay 1982), with most females, sub adults, and calves going to the Chukchi Sea, and most males going to Bristol Bay and the Gulf of Anadyr (Jay and Hills 2005). Walrus begin to migrate south with the advance of pack ice during the fall. Walrus haul out of the water to rest and bear young when they are out of the water. Traditional haulout sites along the Chukchi Sea coast are at Cape Thompson, Cape Lisburne, Icy Cape (MMS 2007b), and, more recently, Chukotka (Ovsyanikov 2003).

BWASP survey data indicate that walrus are found throughout the Lease Sale 193 Area including Shell's survey area. Broken ice along shallow water is an important habitat for walrus, because their young often cannot dive for extended periods of time and need access to haulouts so they can rest and limit the time spent in cold water. Ice also provides a moving platform that increases the likelihood of finding fresh sources of food with each foraging trip. Ice is also important as a platform for giving birth (Fay 1982).

The current size of the Pacific walrus population is not accurately known. Surveys by the United States and Russia between 1975 and 1990 produced population estimates that ranged from 201,039-234,020 (Garlich-Miller et al. 2011). However, these estimates are considered conservative and have large confidence intervals (Gilbert et al. 1992). A coordinated U.S.-Russian walrus population assessment was conducted in 2006 using thermal imagery which is thought to identify only walrus that are hauled out on the ice, and satellite telemetry data to

adjust the numbers to account for walrus in the water. The resulting minimum Pacific walrus population estimate was 129,000 individuals (USFWS 2010a). This minimum population estimate is known to be negatively biased as only about 50 percent of available sea ice habitat was surveyed (USFWS 2010a).

3.9 Sensitive Biological Resources

Areas identified as sensitive biological habitats near the survey area based on their importance to wildlife and subsistence resources include Ledyard Bay, Peard Bay, and Kasegaluk Lagoon.

Ledyard Bay

Ledyard Bay contains the federally designated Ledyard Bay Critical Habitat Unit (LBCHU) for spectacled eiders. The LBCHU was designated because of the areas importance to migrating and molting spectacled eiders.

Peard Bay

A large concentration of spring and fall waterfowl combined with several seabird colonies occupying the coastal waters make Peard Bay a highly important area for biological resources (Kinney 1985, USFWS 1996, Davis and Thompson 1984). It is an important area for spectacled eiders, yellow-billed loons, and shorebirds (Brown 2001). Polar bear den along and just inland from the shore and spotted seal haulouts are prevalent.

Kasegaluk Lagoon

Kasegaluk Lagoon supports large aggregations of beluga whales, spotted seals, and black brant. Productive lagoon waters provide important habitat for summer concentrations beluga whale and spotted seal haulouts. Kasegaluk Lagoon attracts a diversity of waterfowl and coastal seabirds exceeding productivity of other Arctic Alaska lagoon systems (Johnson 1993; Johnson et al. 1992, 1993). Subsistence species such as common eider occupy lagoon waters during summer. The lagoon is particularly important to Pacific black brant during molting and fall staging periods. Polar bear den near the lagoon, and grizzly bears may concentrate to feed on marine mammal carcasses.

3.10 Offshore Cultural Resources

Offshore cultural resources include historic cultural resources and prehistoric cultural resources. Submerged historical resources include shipwrecks, submerged aircraft, and abandoned items of historical importance. Submerged prehistoric cultural resources include archaeological sites on relic sub-aerially exposed landforms. Submerged prehistoric archaeological sites may be found in the Chukchi Sea in areas with water depths less than 200 ft (60 m) (MMS 2007b). The present day 200-ft (60-m) isobath is the location of the shoreline 13,000 years ago when the sea level was much lower and current archaeological theories assert human populations were moving into North America from Asia across the Bering Land Bridge (Bigelow and Powers 2001, Holmes 2001).

3.11 Socioeconomic Resources

Community Profiles

North Slope Borough: The North Slope geographic area includes three regions with different climate, drainage, and geological characteristics: the Arctic Coastal Plain, the Brooks Range Foothills, and the northern portion of the Brooks Range. Most inhabitants of villages in the region are Inupiat Natives. Traditional whaling and other subsistence hunting, fishing, trapping and gathering activities are vital to the Inupiat culture throughout the region. Most of the houses in Borough towns and or Villages have clean drinking water and are plumbed. In addition to the NSB Power and Light System generates electricity from diesel fuel (NSB 2005).

Villages: Four villages are located along the northeastern Chukchi Sea coastline, Barrow, Wainwright, Point Lay, and Point Hope. Only Wainwright is in close proximity to the survey area. These villages are accessible only by air, and by shallow draft vessels and barges during ice free periods. Barrow, the borough seat and hub for the North Slope has a population of just over 4,000 with about 75 percent being Inupiat. Wainwright's population was 560 in 2003 with about 90 percent being American Indian or Alaska Native. The population of Point Lay was about 260 in 2003 with approximately 83 percent being American Indian or Alaska Native. Point Hope's population was estimated at 764 in 2003 with about 87 percent being American Indian or Alaska Native. Additional demographic information is provided in the EIA (Shell 2011b).

Employment

The NSB is the predominant economic driver on the North Slope. Oil and gas development within its geographic boundaries generates revenues for building infrastructure and extending public facilities and services; however, most of the NSB residents in the workforce do not have jobs in the oil and gas industry. The largest employer is the NSB with most of the residents working for the NSB government, NSB School District, city government, and state or federal government. A detailed breakdown of the employments for each town and or Villages within the NSB is provided in the EIA (Shell 2011b).

Subsistence

Shepro et al. (2003) reported that almost all Iñupiat households in the NSB utilize subsistence food sources (Table 3.11-1). Harvest from subsistence activities is shared among family, friends, the community, between North Slope communities, and with others as far away as Fairbanks and Anchorage. Whaling crews have been traditionally and continue to be based on kinship relationships (MMS 2007b).

Table 3.11-1 NSB Household Consumption of Subsistence Resources

Consumption [1,2]	1998		2003	
	Households	Percentage	Households	Percent
None	35	3	165	13
Very little	128	12	217	17
Less than half	211	20	182	14
Half	216	21	241	19
More than half	188	18	183	14
Nearly all	134	13	165	13
All	126	12	130	10
Total	1,038	100	1,283	100

Subsistence Resources

Chukchi Sea village residents utilize many marine resources for subsistence. Regional subsistence activities include fishing, waterfowl and sea duck harvests, and hunting for seals, polar bears, walrus, and bowhead and beluga whales with marine mammals providing the majority of the harvest (Tables 3.11-2 and 3.11-3). For a further discussion of the subsistence resources used in some of the communities within the NSB is discussed in detail in the EIA (Shell 2011b).

Table 3.11-2 Edible Pounds in the Annual Subsistence Harvest for Chukchi Sea Villages

Resource	Barrow [1]		Wainwright [1]		Point Lay [1]		Point Hope [1]	
	lbs	percent	lbs	percent	lbs	percent	lbs	percent
Marine mammals	508,181	58%	243,595	69%	76,853	72%	262,009	78%
Terrestrial mammals	14,683	25%	83,389	24%	21,426	20%	35,548	11%
Fish	118,471	14%	17,385	5%	2,983	3%	30,589	9%
Birds/eggs	29,446	3%	7,211	2%	5,836	5%	9,429	3%
Total	870,781	100%	351,580	100%	107,098	100%	337,575	100%

[1] Source: MMS 2008a citing ADF&G 1995, 1996; Fuller and George 1997.

Table 3.11-3 Percent of Subsistence Harvest Represented by Marine Mammal Species

Resource	Years[1,2,3]	Barrow	Wainwright	Point Lay	Point Hope
Bowhead	1962-1982	21.3%	8.2%	--	22.3%
	1989	74%	42%	0%	9%
Beluga	1962-1982	0.5%	2.7%	--	6.5%
	1989	0%	0%	84%	52%
Walrus	1962-1982	4.6%	18.5%	--	2.9%
	1989	15%	49%	6%	21%
Ringed seal	1962-1982	4.3%	4.4%	--	14.8%
	1989	3%	1%	3%	0%
Spotted seal	1962-1982	--	--	--	--
	1989	0%	0%	3%	0%
Bearded seal	1962-1982	2.9%	2.3%	--	8.9%
	1989	4%	2%	3%	0%
Total	1962-1982	38.1%	36.1%	--	55.4%

[1] 1962-1982 data from MMS1991 citing ACI and SRBA 1984 and Stoker 1983
[2] 1962-1984 data is for hair seals which includes ringed seals and spotted seals
[3] 1989 data is from MMS 2008a

Minority and Lower Income Groups

With their subsistence lifestyle and culture, Inupiat residents of the North Slope are considered a minority/Native American community under the Presidential Executive Order on Environmental Justice. The Inupiat are a minority population in the State of Alaska. Although the overall quality of life has improved for many North Slope residents as oil and gas revenues have come into the NSB, providing funding for public facilities and services, poverty levels in communities outside Barrow have been increasing (NSB 2005). In 1998, 76 households in the NSB were either at the poverty level or considered to be "very low income" (NSB 2005), by 2003 this had increased to 100 households (Shepro et al. 2003). Of those families in the NSB whose incomes were below the poverty line in 1999, 86 percent were Native (Northern Economics, Inc. 2006). Table 3.11-4 shows the poverty levels in Point Lay, Point Hope, and Wainwright.

4.0 ENVIRONMENTAL IMPACTS

The survey program will take place offshore and will have little or no direct or indirect environmental impacts on terrestrial resources. Based on a review of the project description, review of monitoring reports from past surveys, and a review of the literature, the following aspects of the 2013 Chukchi Sea Open Water Survey Program were identified as having potential to impact the marine environment:

- survey program air emissions
- vessel traffic – presence and sound energy
- aircraft traffic – presence and sound energy
- vessel and geotechnical coring - discharges
- sound energy generated by the geotechnical and geophysical equipment

4.1 Direct and Indirect Impacts

The results of an assessment of which of the Chukchi Sea resources described in Section 3 could potentially be affected by the above-listed aspects of the survey program are presented below in Table 4.0-1. Potential direct and indirect impacts on these resources from the identified impact factors are described below. Cumulative impacts are addressed in Section 4.2.

Table 4.0-1 Screening Analysis for Potential Effects on Resources from the Survey Program

Resource	Impact Factor [1]					
	Air Pollutant Emissions	Vessel Discharges	Aircraft Traffic	Vessel Traffic	Geotechnical Coring	Geophysical / Geotechnical Sound
Air Quality	+	-	-	-	-	-
Water Quality	-	+	-	-	+	-
Sediments	-	-	-	-	+	-
Lower Trophic	-	+	-	-	+	+
Fish	-	+	-	+	+	+
Birds	-	+	+	+	+	+
Mammals	-	+	+	+	+	+
T&E Species	-	+	+	+	+	+
Sensitive Areas	-	+	+	+	+	-
Subsistence	-	+	+	+	+	+

[1] Cells with a + indicate the assessed aspect of the survey program could potentially affect the resource

4.1.1 Air Pollutant Emissions

Air quality in the Chukchi Sea and onshore on the North Slope is good, as described in Section 3.1. The 2013 Open Water Survey Program will emit air pollutants, primarily through the use of combustion engines, boilers, and incinerators on survey vessel, and possibly from a helicopter if one is used.

Impact of Air Pollutant Emissions on Air Quality

Estimates of the amounts of regulated air pollutants that might be emitted by the vessel during the planned surveys are provided in Table 4.1.1-1. These emissions are small and would be expected to have no effect on local or regional air quality.

Table 4.1.1-1 Estimated Emissions of Air Pollutants from the Open Water Marine Survey Program

Source	Emissions (tons) [1]				
	NO_x	SO_2	PM	VOC	CO
Main Propulsion Engines	21.95	0.02	1.29	3.1	27.19
Main Generators	15.78	0.01	0.93	2.23	19.55
Boilers	0.39	0	0.04	0	0.1
Incinerator	0.06	0.05	0.15	0.06	0.22
Helicopter	0.12	0.04	0.003	0.01	0.02
Total	38.3	0.12	2.413	5.4	47.08

[1] Source: Air Sciences 2012

4.1.2 Vessel Discharges

The survey vessel will have an NPDES VGP and operate under the requirements of the permit if it enters State waters. All discharges will meet the requirements set forth in the NPDES VGP and MARPOL. Permissible vessel discharges will include graywater, blackwater, deck drainage, cooling water, bilge water, and ballast water. Blackwater must be, and will be treated in a U.S. Coast Guard (USCG)-approved marine sanitation device (MSD) prior to discharge. No treated sanitary waste water will be discharged within three miles of the coastline. Deck drainage is water that collects on impervious surfaces of the vessel and consists largely of rainwater, seaspray, and washwater. Deck drainage is collected and treated in an oily water separator before discharge. Estimates of the volumes of these types discharges that could occur based on vessels that have been used in the past are provided n Table 4.1.2-1.

Table 4.1.2-1 Non-Drilling Wastewaters Expected to be Generated and Discharged

Vessel	Crew	Volume Discharged per Day		
		Graywater [1]	Blackwater [2]	Deck Drainage [3]
Fugro Explorer	48	141 bbl	13 bbl	12 bbl
Ocean Pioneer	35	83 bbl	8 bbl	7 bbl
Fugro Synergy	84	200 bbl	18 bbl	20 bbl
Nordica	82	195 bbl	35 bbl	28 bbl

[1] Graywater is domestic waste – laundry, galley, lavatory – volume based on 100 gal/day/POB
[2] Blackwater is sanitary waste – treated wastes from toilets – volume based on 9 gal/day/POB
[3] Deck drainage calculated on ship surface area and average precipitation

Bilge water will be treated in an oily water separator before discharge. Ballast water is water held in ballast water tanks pumped in or out to maintain vessel stability. In accordance with 33 CFR 151, Subpart D, any survey vessel coming from another COTPZ will undergo one or more complete mid-ocean ballast water exchanges before entering U.S. waters or the Alaska COTPZ from another zone to prevent the unintentional introduction of non-native species into the Chukchi Sea. Food waste will also be incinerated on the vessel.

Impact of Vessel Discharges on Water Quality

The EPA evaluated the environmental impact of this type and quantity of vessel discharge in territorial seas as part of their NPDES program prior to issuing their general permits for vessels VGP and Oil and Gas Exploration (EPA 2006, 2008, 2012), and concluded they would not result in unreasonable degradation of ocean waters, which means they will not result in:

- Major adverse changes in the ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities
- Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms
- Loss of aesthetic, recreational, scientific, or economic values.

Graywater includes wastewaters from showers, sinks, laundries, and galleys on the vessel. Gray water does not require treatment prior to discharge as only environmentally friendly soaps and solutions (phosphate free, water soluble, nontoxic, biodegradable) are used aboard the vessel engaged in the survey operations. Organic compounds in the wastes will result in some increases in biological oxygen demand (BOD) in ambient waters and increased suspended solids. These effects will be limited to the area immediately surrounding the discharge location as they would be quickly diluted and dispersed due to the water depths and currents found in the survey area, and would last only minutes longer than the discharges. The effects are therefore considered to be negligible and short term.

The primary pollutant of concern in deck drainage is oil that could be entrained in the waters as they move across oily surfaces on the deck and elsewhere. Vessel operators will minimize the introduction of on-deck debris, garbage, residue and spill into deck washdown and runoff discharges. Machinery on deck will have coamings or drip pans to collect any oily water from machinery and prevent spills, and the drip pans must be drained to a waste container for proper disposal and/or periodically wiped and cleaned.

Seawater cooling systems use ambient seawater to absorb the heat from propulsion and auxiliary mechanical systems. The water is circulated through an enclosed system and does not come in direct contact with machinery, but still may contain small amounts of sediment from water intake and traces of hydraulic or lubricating oils. The temperature of the discharged cooling water is elevated over the temperature of the receiving seawater. For examples, modeling (Farmayan 2011) of the thermal plume created by much larger cooling water discharges associated with exploration drilling in the Chukchi Sea indicate that such discharges are only slightly warmer than ambient waters when returned to the environment, and that the cooling water quickly returns to ambient conditions due to rapid dilution and dispersion given the open water conditions. The modeling indicated that the small initial difference in temperature (approximately 2.5 °F [1.4 °C]) would be reduced by 99 percent within 33-164 ft (10-50 m). Any measureable effects on water quality due to these discharges would be restricted to the immediate vicinity of the discharge and would be negligible and short-term, lasting only as long as the discharge.

Ballast water is seawater pumped into or out of ballast water tanks to manage vessel draft, buoyancy, and stability. Discharge volumes and rates vary by vessel type; larger survey vessels such as the *Fugro Explorer* have ballast water capacities of over 6,000 bbl. Ballast water may contain rust inhibitors, flocculent compounds, epoxy coating materials, zinc or aluminum (from

anodes), iron, nickel, copper, bronze, silver, and other material or sediment from inside the tank, pipes, or other machinery (EPA 2008). USCG regulations (33 CFR 151 Subpart D) mandate that vessel operators maintain a ballast water management plan, discharge the minimal volumes necessary for operations, clean ballast tanks regularly to remove sediments, and minimize or avoid uptake of ballast waters near sewage outfalls, areas of active dredging, where propellers may stir up sediments. Given these requirements and practices, contaminants would be expected to be in low concentrations such that any effects on water quality would be negligible.

Water quality effects of discharges of deck drainage, cooling water, ballast water, and bilge water, associated with the Shell's survey program will be minor and temporary, lasting only minutes longer than the specific activity. The EPA (2006, 2008, 2012) has determined that discharges of deck drainage, cooling water, and bilge water from vessels would not result in unreasonable or extensive water quality degradation in the Chukchi Sea.

Blackwater discharges are subject to Section 302 of the Clean Water Act (CWA) and USCG regulations at 33 CFR Part 159. Primary pollutants of concern in blackwater are BOD, TSS, coliform bacteria, and residual chlorine. Only blackwater that is first treated in a Type II MSD will be discharged. Treatment will reduce coliform bacteria and suspended solids to levels to which are 100 colonies / 100 mL fecal coliform and 150 mg/L respectively, or lower, as stipulated by MSD regulations. Organic compounds in the wastes will result in some increases in BOD in ambient waters and increased suspended solids. Increases in BOD, TSS and chlorine will be limited to the area immediately surrounding the discharge location as they would be quickly diluted and dispersed due to the water depths and currents found at the prospect, and would last only minutes longer than the discharges. The effects are therefore considered to be negligible and short term.

Impact of Vessel Discharges on Lower Trophic Organisms

The discharge of sanitary and domestic wastes will have little to no effect on lower trophic organisms. Some changes in water quality, such as increases in TSS, BOD, and chemical oxygen demand will occur but will be limited area immediately adjacent to the discharge site due to rapid dilution and dispersion into the water column. Discharges of sanitary and domestic wastewaters will increase the amount of organic materials and nutrients in the water, which could result in increased primary productivity.

Discharge of non-contact cooling water, ballast water, desalination unit wastes, and deck drainage would also have minor effects on water quality such as changes in temperature, salinity, and pH. These effects would largely be limited to the area within 328 ft (100 m) of the discharge location, and would not be expected to affect plankton or benthos in the area. Cooling water discharges will be only a few degrees above ambient and that difference will likely be reduced by 99 percent or more within 164 ft (50 m) of the discharge location. Some entrainment of meroplankton (larval fish and fish eggs) and zooplankton will occur in the seawater but entrainment effects would not be sufficient to result in a noticeable change in regional zooplankton or fish populations. Thus, these impacts are considered minor and short term, lasting less than one year.

Under the United States ballast water management regulations 33 CFR151 Subpart D, all vessels equipped with ballast water tanks must develop and maintain a Ballast Water Management Plan. In Alaskan waters, 33 CFR 151 requires vessels traveling from international waters or from one COTPZ to another, undergo a mid-ocean exchange of ballast waters (or federally approved

biocide or ozone) before entering the COTPZ to prevent exotic species from being brought from one ocean to another or into coastal waters. There will therefore be little or no opportunity for the introduction of exotic species and no impact on lower trophic resources.

Impact of Vessel Discharges on Marine Fish

The discharge of sanitary and domestic wastes would be expected to have no effect on fish. Some changes in water quality, such as increases in turbidity, and biological and chemical oxygen demand would occur in the area immediately adjacent to the discharge site but would be limited due to rapid dilution and dispersion into the water column. These waste streams are not hazardous so impacts to fish, if any, would be temporary and short term.

Discharge of non-contact cooling water, ballast water, desalination unit wastes, and deck drainage would also have minor effects on water quality such as minor changes in temperature, salinity, and pH. These effects would largely be limited to the area within 328 ft (100 m) of the discharge location, and would not be expected to affect fish in the area. Cooling water discharges will be only a few degrees above ambient and will likely reach ambient temperatures within about 164 ft (50 m) or less, of the outfall. Some entrainment of juvenile and larval fish and fish eggs could occur in the intake. Entrainment effects would not be sufficient to result a noticeable change in regional fish populations due to the use of a single vessel; few ballast exchanges, and the high natural mortality rates. Any and all effects of permitted vessel discharges on fish would be negligible and temporary lasting only minutes or hours after the discharge ceases, likely consisting only of displacement of adult fish and some entrainment of eggs and larvae.

Impact of Vessel Discharges on Birds

Vessel discharges will be conducted under MARPOL and USCG regulations. There will be no discharge of free oil, floating solids, or trash that could potentially oil, entangle, or otherwise affect marine birds. Only sanitary wastes treated in a MSD will be discharged. Food wastes, which could potentially attract birds, will not be discharged; all food wastes will be incinerated. Discharges will result in slight changes in pH, temperature, TSS, and BOD within the immediate vicinity of the vessel, but these water quality effects would have no effect on birds. Any indirect effects on bird prey or habitat would be negligible and short term, lasting only as long as the discharge is ongoing. The discharges would have no or negligible effects on birds and no effect on bird populations.

Effects of Vessel Discharges on Threatened and Endangered Birds and Critical Habitat

Impacts of vessel discharges on Steller's and spectacled eiders (threatened), Kittlitz's murrelet (candidate) and yellow-billed loon (candidate) would be identical to those discussed above for other marine birds; however, these species are found in low densities in the survey area as indicated by their status and would therefore be less likely to be affected. Discharges would not take place in areas known to have concentrations of these birds such as Ledyard Bay, Kasegaluk Lagoon, or Peard Bay. All discharges would be conducted per requirements of MARPOL and USCG regulations, which prohibit the discharge of free oil. All water quality effects on the habitat would be expected to be ameliorated within 328 ft (100 m) of the vessel and within minutes of discharge cessation. All designated spectacled and Steller's eider critical habitat is located outside the survey area and would not be affected by vessel discharges.

Analysis of Impact of Vessel Discharges on Marine Mammals

Vessel discharges will be conducted under MARPOL and USCG regulations; there will be no discharge of free oil, floating solids, or trash that could affect marine mammals. Only sanitary wastes treated in a certified Type II MSD will be discharged. Fecal coliform concentrations allowed in the effluent are near levels determined to be safe for human exposure for *E. coli* (EPA 1986). Because *E. coli* is a subset of fecal coliform, these levels are not expected to result in an increase in pathogens harmful to marine mammals. Cooling water forms the bulk of such discharges by volume and is essentially uncontaminated seawater that is a few degrees warmer than ambient waters at discharge. This difference would be quickly reduced mixing and would have no direct or indirect effects on marine mammals. Vessel discharges will result in slight changes in pH, temperature, TSS, and BOD in the water column, but these effects would be minor and limited to the immediate vicinity of the discharge due to rapid dispersion in the open ocean conditions. These effects will have little or no effect on marine mammals in the area and only negligible short term effects on marine mammal habitat.

Effects of Vessel Discharges on Threatened and Endangered Marine Mammals

Impacts of vessel discharges on bowhead, humpback, and fin whales (endangered), ringed and bearded seals (threatened), Pacific walrus (candidate) and polar bear (threatened) would be identical to those discussed above for other marine mammals. These discharges would result in only minor and temporary changes in water quality, such as increases in turbidity and biological and chemical oxygen demand. These effects would largely be limited to the area within the immediate vicinity of the vessel, an area, which whales will probably avoid due to sound and activity associated with vessel presence.

Impact of Vessel Discharges on Sensitive Resources

Vessel discharges will have very minor effects on the water column as described above, and these effects would be ephemeral and restricted to the area immediately down current of the discharges. The EPA (2006, 2008, 2012) has determined that these types of discharges do not result in unreasonable degradation of ocean waters. All discharges would occur more than 3.0 mi (4.8 km) from, and have no effect on, the identified sensitive resources.

Impact of Vessel Discharges on Subsistence

The effects of the presence of the survey vessel on subsistence are addressed above under the *Impacts of Vessel Traffic on Subsistence* and the effect of the sound energy generated by the geotechnical equipment on subsistence are addressed above under the *Impacts of Sound Generation by Geophysical and Geotechnical Equipment on Subsistence.* The primary physical effects of vessel discharges will be ephemeral changes in water quality including increased TSS, BOD, COD, and water temperature and pH, which could potentially result in displacement of subsistence resources. These effects would be limited to a very small area in the vicinity of the survey vessel, and will likely be limited to the area from which marine mammals and birds have already been displaced due to vessel presence and sound energy generated by operation of the vessel and geotechnical equipment. Thus vessel discharges are not likely to result in any incremental increase in potential effects on subsistence. The reader is referred to the above-referenced sections of the ER for a more detailed analysis of these potential effects.

4.1.3 Aircraft Traffic

There is a remote possibility that a helicopter may be used to assist with crew change and/or transport small supplies such as groceries at the same time. Aircraft use is not planned for the marine survey program but is included in this impact analysis due to the possibility that they may be. At most maybe a couple of flights between the Barrow or Wainwright airports to the survey vessel would ocuur within a period of between mid-July and mid-October 2013. Disturbance from aircraft may result from visual (presence) and/or audio cues (sounds generated by the aircraft). Both the level and duration of sounds received underwater from passing aircraft depend on altitude and aspect of the aircraft, receiver depth, and water depth (Tables 4.1.3-1 and 4.1.3-2). Received sound level decreases with increasing altitude of the aircraft and with increasing depth to the receiver when the aircraft is directly overhead

Table 4.1.3-1 Reported Underwater Sound Levels from Helicopter over Offshore Areas

Aircraft	Water Depth (ft/m)	Received Underwater Sound Level (dB)								
		Altitude 2,000 ft (610 m)		Altitude 1,500 ft (457 m)		Altitude 1,000 ft (305 m)		Altitude 500 ft (152 m)		
		10 ft (3 m)	30 ft (9 m)	10 ft (3 m)	30 ft (9 m)	10 ft (3 m)	30 ft (9 m)	10 ft (3 m)	30 ft (9 m)	60 ft (18 m)
Sikorsky 61	121/37	nd	nd	nd	nd	nd	nd	102	111	105

[1] Source: Greene 1985, nd – no data collected
[2] Measured sound levels relative to one µPa at one meter distant for five types of aircraft at altitudes of 152 m to 610 m from hydrophones at depths of 3 m, 9 m, and 18 m below the water surface

Table 4.1.3-2 Duration and Audibility of Underwater Sound from Helicopters

Aircraft [1]	Altitude, ft (m)	Water Depth, ft (m)	Sea State	Sound Level (dB) [2]	Duration at Depth (sec)
					30 ft (9 m)
Bell 212	500 (152)	82 (25.0)	1	100	16-21
Bell 212	1,000 (305)	82 (25.0)	1	100	18-27
Bell 212	1,500 (457)	82 (25.0)	1	100	nd
Bell 212	2,000 (610)	82 (25.0)	1	100	26
Bell 214ST	500 (152)	72 (22.0)	3	100	11

[1] Source: Greene 1985
[2] In 20-1000 Hz frequency range

Impact of Aircraft Traffic on Birds and Marine Mammals

Effects of Aircraft on Birds, Threatened and Endangered Birds, and Critical Habitat

Helicopters flights can disturb birds, with the potential to flush the birds, cause increased movement (Derksen et al. 1992) with potential effects on energetic and body weight (Ward and Stehn 1989), alter habitat use (Belanger and Bedard 1989), or decrease productivity at nesting sites. These effects are thought to be of greatest impact at nesting colonies, or areas where the birds congregate for molting or staging before migration.

Helicopters at lateral distances of 1.0-5.6 mi (1.6-9.0 km) have been shown to evoke various responses from staging and molting waterfowl (Owens 1977, Mosbech and Glahder 1991, Ward and Stehn 1989, Derksen et al 1992); however, most responses are brief, lasting seconds to about five minutes (Ward and Stehn 1989, Derksen et al. 1992). The level of response varies with flock size and altitude, decreasing with altitude from 500-1,000 ft (152-305 m) (Ward and Stehn

1989), but responses to helicopters at altitudes of up to 5,000 ft (1,525 m) have been observed (Derksen et al. 1992). Gollop ety al. (1974a) subjected molting sea ducks in the Beaufort Sea to experimental helicopter overflights at altitudes of 100-750 ft (30-229 m) and horizontal distances of 100-400 yd (91-366 m); they found the flights caused some disturbance but in all cases normal behavior resumed quickly. Swimming and feeding activities of long-tailed ducks were not affected, surf scoters appeared to swimmand feed more. There was no appreant change in the number of birds utilizing the area during the experimental period. Experimental studies and modeling indicates that flight frequencies on the order of 50 overflights / day would be required to effect energetic sufficiently to result in bird weight loss (Ward and Stehn 1989). Given the very few helicopter flights, if any, that might occur with the survey program, the minimum flight altitude of 1,500 ft (457 m), and avoidance of areas noted as especially important for staging and molting birds (Peard Bay, Kasegaluk Lagoon, and Ledyard Bay), the flights will have negligible and brief effects on molting, staging, resting, and feeding waterbirds, consisting of momentary behavioral responses.

Bird nesting colonies can sometimes be disturbed by aircraft resulting in a loss of productivity (Carney and Sydeman 1999); adult birds flushed from nests can cause displacement of eggs and young from the nest and/or render eggs and young more vulnerable to predation and exposure to weather. However, studies indicate that these types of effects can be avoided if certain altitudes and distances are maintained. Rojek et al. (2007) observed a relatively low level of disturbance from helicopters at a murre cliff colony and concluded aircraft at altitudes of >1,000 ft (>305 m) would not cause disturbance to breeding sea birds. Fjeld et al. (1988) reported that most aircraft flushing responses at murre colonies was limited to flights within 1.5 mi (2.5 km). The nearest large cliff colonies are located more than 100 mi (160 km) south of the survey area and will not be affected by the survey program.

Four bird small coastal bird colonies of common eiders, arctic terns, and horned puffins are located between Icy Cape and Barrow shoreward of the survey area. Gollop et al. (1974a) studied the reaction of similar small colonies of arctic terns, glaucous gulls, on spits in the Beaufort Sea and found these colonies / species resistant to displacement from helicopters, especially common eiders. Nesting common eiders exhibited no response to helicopters. The arctic tern was the most sensitive with 100 percent of nesting and non-nesting birds flushing in response to helicopters at altitudes of up to 1,000 ft (305 m), but no response 1,500 ft (455 m). A few non-nesting gulls flushed from overflights at 1,000 ft (305 m) but the number was not substantial. All observed flushing responses were brief with the birds returning within minutes. The helicopter flights were found to have no apparent effect on reproductive success. Shell's minimum altitude requirement of 1,500 ft (457 m) would likely avoid all responses from nesting common eiders and most if not all responses from other species. Few flights are involved, if any. Any responses that might occur would likely consist of alert postures, head bobbing, increased movement, and/or flushing, but any flushed birds would be expected to return to the nest within seconds or a few minutes. Any such effects would be brief and negligible

Disturbances to threatened and endangered birds would be similar to other birds as described above. All of these species are found in low densities in the survey area so aircraft would result in no more than brief disturbance of a few if any birds offshore. Kittlitz's murrelet does not nest along the Chukchi Sea. Yellow-billed loons and spectacled and Steller's eiders (Rojek and Martin 2003, Rojek 2005, 2006, 2007, 2008) nest inland in areas that would not be traversed by helicopters. As with other eiders (Gollop et al. 1974a), nesting spectacled eiders have been

observed to exhibit some tolerance to aircraft by nesting within 820-2,460 ft (250-750 m) of the Deadhorse airport (TERA 1996, Martin 1997). Areas such as LBCHU, Kasegaluk Lagoon, and Peard Bay where Steller's or spectacled eiders congregate in large numbers to molt or stage would not be traversed. No flights would occur in critical habitat (LBCHU). Any impacts to threatened and endangered birds would be brief and negligible.

Effects of Aircraft on Marines Mammals, Threatened and Endangered Mammals, and Critical Habitat

Aircraft traffic could potentially result in some disturbance of marine mammals. Gray whales sometimes show avoidance behavior in response to air traffic sound energy. The Scientific Research Association (1988) reported that gray whales usually exhibit avoidance behavior when helicopters flew lower than 1,198 ft (365 m). Mothers with calves appear more sensitive to air traffic (Clarke et al. 1989). Some gray whales have been observed reacting to sound energy generated by helicopters flying within 328 ft (100 m) of the whales (Richardson 1998). SRA (1988) reported that migrating gray whales never reacted overtly to a Bell 212 helicopter at altitudes of more than 425 m.

Richardson (1995b) observed some belugas exhibiting avoidance behaviors in reaction to aircraft flying at altitudes less than or equal to 820 ft (250 m), most, however, showed no reaction to aircraft flying at altitudes greater than or equal 492 ft (150 m). The amount of time that belugas may be affected by low-flying aircraft is usually only seconds (Stewart et al. 1982). In one study, most reactions of beluga whales were observed (Patenaude et al. 2002) when exposed to helicopters that approached within 820 ft (250 m).

Threatened and endangered whales in the Chukchi Sea include the bowhead, humpback, and fin whale; however, the bowhead is the only species abundant enough to expect one might be encountered by an aircraft. The most common bowhead reaction to aircraft traffic is avoidance behavior, such as diving. Richardson et al. (1985b) observed responses of summering bowhead to fixed wing aircraft and helicopters (Sikorsky S-76). Overflights of fixed-wing aircraft sometimes evoked responses at altitudes of less than 1,000 ft (305 m), infrequently at altitude of 1,500 ft (457 m), and virtually never at altitudes greater than 2,000 ft (610 m). No overt responses were observed to helicopter overflights at an altitude of 500 ft (153 m). The researchers concluded that bowhead whale behavior is generally not disturbed by aircraft if an altitude of 1,500 ft (>457 m) is maintained. The most common bowhead reactions to overflights were sudden or hasty dives, but changes in orientation, dispersal or movement out of the area, and change in activity were sometimes noted. Bowheads that were engaged in social activities or feeding or were less sensitive than those that were not. Whales in shallow water <33 ft (<10 m) were often very sensitive. Richardson et al. (1995a) have reported disturbances such as hasty dives have been observed in response to low-level helicopter overflights. Richardson and Malme (1993) reported that most bowhead whales in their study did not show a response to helicopters flying at altitudes above 500 ft (150 m).

Documented reactions of pinnipeds to aircraft overflights range from simply becoming alert and raising the head, to escape behavior such as hauled out animals rushing to the water. Ringed seals hauled out on the surface of the ice have shown behavioral responses to helicopter overflights with escape responses most probable at lateral distances <656 ft (<200 m) and overhead distances <492 ft (≤150 m; Born et al. 1999). Hauled out spotted seals showed immediate reaction to the presence of aircraft during surveys by Rugh et al. (1997); they

observed disturbances of spotted seals at altitudes up to 4,500 ft (1,370 m). Spotted seals hauled out on beaches have been observed to leave the beach and enter the water when survey aircraft flew at altitudes of 1,000-2,500 ft (305-760 m) on or more came within 0.6 mi (1 km) (Frost and Lowry 1990, Frost et al. 1993, Rugh et al. 1993, Richardson et al. 1995a). Concentrations of animals hauled out on land seem to react more severely than the scattered small groups found on the sea ice in spring.

Low-flying helicopters and fixed wing aircraft have often been observed to cause ringed and bearded seals to dive into the water, but this is not always the case (Burns and Harbo 1972, Burns and Frost 1979, Alliston 1981). Documented reactions of ringed and bearded seals to overflights range from simply becoming alert and raising the head, to escape behavior such as hauled out animals rushing to the water. Ringed seals hauled out on ice have shown behavioral responses to helicopter overflights with escape response most probable at lateral distance of <656 ft (<200 m) and overhead distances <492 ft (< 150 m) (Born et al. 1999). Brueggeman et al. (1992a) reported that about 6.6 percent of 552 seals (ringed, bearded, and spotted seals but primarily ringed seals) reacted to a twin otter airplane flown in the Chukchi Sea at an altitude of 1,000 ft (305 m). Reactions included diving in the water resulting in a splash, or escaping from ice into the water.

Brueggeman et al. (1991a) evaluated walrus reactions to survey aircraft flying at an altitude of 305 m (1,000 ft) over the pack ice and 152 m (500 ft) in water, and reported that 17 percent of the walrus groups on ice and none in water reacted to the aircraft. Walrus reacted to flights between 197 and 492 ft (60 and 150 m) above sea level within 0.62 mi (1 km) lateral distance by either orienting towards the aircraft or escaping into the water (Brueggeman et al. 1990). Walrus hauled out on land or ice were more sensitive to overflights (Brueggeman et al. 1990). In recent years, walrus have moved to terrestrial haulout sites along the Chukchi Sea coast when ice has retreated far offshore beyond the continental shelf break and preferred feeding areas. Stampedes at these large haulouts can result in deaths of animals, particularly smaller juveniles and calves (Fischbach et al. 2009).

Potential impacts from aircraft traffic on polar bears are expected to be negligible. The USFWS (2008) similarly concluded in its Programmatic BO that routine aircraft has little to no effect on individual polar bears or the population. It was noted that any reactions of non-denning bears would be limited to short-term changes in behavior before bears resumed their normal activity (denning bears will not be impacted because the timing of the project does not overlap with denning periods). Per Shell mitigation measures, helicopters will maintain a 1,500 ft (450 m) minimum altitude and will not operate within 0.5 mi (800 m) of bears hauled out onto land or ice. With these measures in place, aircraft traffic associated with the survey program will have a negligible, if any, effect on polar bears. There is currently no designated critical habitat for polar bears.

Aircraft traffic associated with the planned open water marine survey program is likely to cause only temporary behavioral disturbance, if any, and possibly deflection away from the sound source. Although aircraft may evoke responses from marine mammals, the above-reviewed information indicates that helicopter flights associated with Shell's marine survey program, which will conducted at an altitude of ≥1,500 ft (457 m) will result in no or very few disturbances of bowhead whales gray whales, belugas, and likely other cetaceans. Helicopters may momentarily alter the behavior of bowheads in the form of hasty dives and changes in

respiration rates. Impacts on fin whales and humpback whales are unlikely but if they were to occur would be would be similar to the bowhead. Any changes in gray whale behavior due to aircraft traffic will be minor and temporary lasting only minutes or hours at the most. Encounters with aircraft would also not be expected to have any more than a brief effect on belugas (Richardson et al. 1991; Richard et al. 1998), and any potential deflection or displacement would likely be temporary.

The nearest known spotted seal haulouts are on barrier islands of Kasegaluk Lagoon located to the south of the survey area and away from any helicopter traffic. There may be seal haulouts near Peard Bay, but helicopters will avoid this area as well. Given these mitigation measures, the small number of helicopter flights that be occur, and the low density at which marine mammals area found, aircraft impacts associated with the open water marine survey program will be negligible and temporary consisting of brief behavioral responses by gray whales, belugas, harbor porpoises, and spotted seals.

Shell's mitigation measures prohibit aircraft flights within below 1,500 ft (457 m) and within 0.5 mi (0.8 km) of walrus hauled out on ice, and below 3,000 ft (914 m) within 1.0 mi (1,610 m) of walrus groups observed on land will reduce the disturbance to walrus. Shell will use real-time information from its 4MP as well as communications with the various agencies and villages to monitor the locations of terrestrial haulouts that may occur along the Chukchi Sea coast during the program. Few helicopter flights are expected to occur. Given these altitude and avoidance measures, any disturbance effects on any of marine mammal species should be minor and temporary.

Analysis of Impact of Aircraft Traffic on Sensitive Resources

Aircraft traffic will have no effect on the identified sensitive resources. Helicopter flight paths will not traverse the LBCHU, Kasegaluk Lagoon, or Peard Bay.

Analysis of Impact of Aircraft Traffic on Subsistence

Helicopter flights associated with the survey program may traverse some coastal waters where subsistence activities are conducted but will have no or negligible effect on subsistence activities due to the small number of flights associated with the program and mitigation measures that will be implemented by Shell.

Effects of Aircraft on Bowhead Whale Hunting

Residents of Wainwright, Point Lay, and Point Hope hunt bowheads primarily during the spring migration in open leads from late March or early April until the first week of June. Shell's operations will commence in mid-July when these spring hunts are over so the survey program would have no impact on these whaling subsistence activities. Barrow residents also hunt bowheads in the fall with fall harvests in recent years occurring between 4 September and 23 October; however, nearly all whales harvested in the fall by Barrow are harvested east of Point Barrow in the Beaufort Sea so there is no opportunity for aircraft traffic in the survey area to affect Barrow fall whaling. Barrow whaling crews do sometimes harvest whales in the fall in the Chukchi Sea as happened in 2007 (Suydam et al. 2008).

In recent years, Wainwright has also hunted in the fall. In October of 2010 Wainwright harvested the first fall bowhead by a northeastern Chukchi Sea village in over 90 years, offshore of Point Franklin north of Wainwright. Wainwright residents have expressed interest in continuing fall whaling efforts in the future, and were successful again in the fall of 2011. The

survey area encompasses some of the coastal waters where fall whaling may be conducted by Wainwright. Shell has mitigation measures in place to avoid any impacts to fall whaling by Barrow or Wainwright, including a system of Subsistence Advisors, Community Liaisons, and Com Centers. Given these measures, vessel traffic is likely to avoid areas of active whaling and have no or negligible effect on fall whaling in the Chukchi Sea.

Effects of Aircraft on Beluga Whale Hunting

The survey area is located north of the areas where Point Hope and Point Lay hunt beluga, and the marine survey program will be conducted after the date when most hunts are complete, so aircraft would have no effect on these hunts. Beluga are occasionally hunted by Barrow residents in coastal waters during July and August, primarily after the spring bowhead hunt; however, interviewed local hunters reported that belugas have not been commonly hunted by Barrow residents in recent years (Sound Enterprises and Associates 2008).

Wainwright residents hunt for beluga in spring leads when bowheads are not present, but the primary hunt occurs during July and August in coastal waters from Icy Cape to Point Franklin within portions of the survey area. Helicopter traffic therefore has the potential to cause some disruption of communal hunts for belugas by disturbing and altering the course of the whales, possibly rendering them more difficult to herd or harvest. Belugas have been observed reacting to helicopters; however, Richardson et al. (1991, 1995b) reported that most spring-migrating belugas exhibit no overt response to helicopters at altitudes of more than 500 ft (150 m), although some exhibited responses such as turning or diving to helicopter flights as high as 1,500 ft (460 m) and within a distance of 700 ft (250 m) laterally. These studies indicate that any effects on belugas from helicopters would be temporary and limited to a very small area along the helicopter flight path. Any effects on the beluga hunt from helicopter traffic associated with the marine survey program would be minor and short term due to Shell's mitigation measures, which include a minimum altitude of 1,500 ft (457 m), and use of its system of Subsistence Advisors and Comm Centers to avoid areas where the beluga hunt may be taking place.

Effects of Aircraft on Polar Bear Hunting

Polar bears are harvested throughout the calendar year, depending on availability, but most commonly in the fall and winter anywhere between September and April depending on the area, and generally within 10 mi (16 km) of the coastline. Most polar bear hunting by Point Lay and Point Hope hunters occurs outside of the survey area and outside of the time period (USFWS 2012) during which the survey would take place. Most recent polar bear harvests reported by Barrow have occurred in February and March (USFWS 2012). Polar bears are harvested from Wainwright throughout much of the year, with peak harvest reported in May and December within 10 mi (16 km) of the community (USFWS 2012).

Because of the locations where most polar bears are harvested and the seasonality of most harvests, aircraft traffic associated with the open water marine survey program will have very limited opportunity to affect polar bear hunting by Barrow or Wainwright residents. Polar bears exposed to aircraft may show curiosity, no effect, or exhibit avoidance behavior resulting in short-term and localized effects, which could disrupt some polar bear hunts, but any effect on polar bears would be brief unlikely affect annual harvest levels (MMS 2008a). Implementation of Shell's mitigation measures including not flying within 0.5 mi (0.8 km) of polar bears observed on land or ice, and maintaining a minimum altitude of 1,500 m (457 m), will minimize the potential for any such effects. Additionally, Shell will use its system of Subsistence Advisors

and Comm Centers to avoid areas where polar bear hunting is occurring and minor due to the small number of flights and the implementation of mitigation measures.

Effects of Aircraft on Seal Hunting

Most ringed and bearded seals are harvested in the winter or in the spring before Shell's open water marine survey program would commence, but some harvest continues into the open water period and could possibly be affected by Shell's planned activities. Spotted seals especially are harvested during the summer. The survey area is located north of areas utilized by Point Hope and Point Lay residents for seal hunting; however, nearshore portions of the survey area are used by residents of Wainwright and Barrow for hunting seals. Thus there is potential that helicopter flights associated with the marine survey program could impact subsistence hunting for seals by disturbing the seals.

Aircraft can disturb bearded, ringed, and spotted seals hauled out on the ice and along the coast on beaches. Low-flying helicopters and fixed wing aircraft have often been observed to cause ringed and bearded seals to dive into the water, but this is not always the case (Burns and Harbo 1972, Burns and Frost 1979, Alliston 1981). Spotted seals hauled out on beaches have been observed to leave the beach and enter the water when survey aircraft flew at altitudes of 1,000-2,500 ft (305-760 m) on or more came within 0.6 mi (1 km) (Frost and Lowry 1990, Frost et al. 1993, Rugh et al. 1993, Richardson et al. 1995a).

Impacts to seals and seal hunting activities from helicopter traffic will be negligible, temporary and localized. Much of the seal hunting is conducted outside of the survey time period. Aircraft will follow direct flight paths from the airport to the survey vessel, minimizing time over coastal waters where hunting occurs. The minimum flying altitude of 1,500 ft (457 m) is sufficient to avoid most disturbance effects on seals, except for spotted seal haulouts. Most known coastal spotted seal haulouts are located to the south of the survey area (Frost et al. 1993), although they may haul out at Point Franklin near Peard Bay as well. This area will be avoided. Shell will use its system of Subsistence Advisors and Comm Centers to avoid areas where seal hunting is occurring. Effects on seal hunting are expected to be negligible.

Effects of Aircraft on Walrus Hunting

Point Hope and Point Lay walrus hunting areas are located to the south of the survey area and would not be affected by the survey program. Walrus are sometimes harvested by Barrow residents in conjunction with the spring bowhead hunt in the Chukchi from Point Barrow to Peard Bay, but the primary effort occurs from late June to mid-September with a peak in August. Wainwright residents hunt walrus in July to August along the retreating ice pack but occasionally harvest walrus that are hauled out on the beaches in late August and September. The survey area encompasses some areas where Barrow and Wainwright residents are known to hunt walrus, could potentially be affected by helicopter traffic.

Walrus hauled out on the pack ice have left the ice when helicopters approached within 1,300-2,000 ft (400-600 m) upwind or 3,300-5,900 ft (1,000-1,800 m) downwind of the animals (Fay et al. 1984). Brueggeman et al. (1990) reported that 12 percent of 34 walrus groups in the open ocean and 38 percent of the walrus groups on the pack ice reacted to the aircraft an altitude of 1,000 ft (305 m) by diving or escaping into the water. Shell helicopter flights would be required to maintain an altitude of 1,500 ft (457 m) and to stay 0.5 mi (0.8 km) from of walrus on land or ice which will minimize potential disturbance of walrus and effects on walrus hunting. Additionally, Shell will use its system of Subsistence Advisors and Comm Centers to avoid areas

where walrus hunting is occurring. With these measures will minimize or avoid impacts to walrus and subsistence walrus hunting. Any such effects would be temporary and minor due to the small number of vessel and helicopter trips that would be undertaken.

Effects of Aircraft on Fishing

Aircraft traffic should have no impact on the availability of subsistence fish resources or subsistence fishing.

Effects of Aircraft on Bird Hunting and Egg Collection

Coastal and marine birds are harvested by residents of all four Chukchi Sea villages; these resources compose a small but important part of the total subsistence harvest (ACI et al. 1984). Harvests occur throughout the spring, summer, and fall, both inland and in or adjacent to coastal waters, and often in conjunction with hunts for marine mammals. Portions of the survey area are used for waterfowl hunting by residents of Wainwright and Barrow.

Helicopter traffic could potentially disturb birds and therefore impact subsistence hunts for birds during the summer and fall. However, given the location and timing of the marine survey program and the mitigation measures in place, these effects are anticipated to be minor. The program involves a small number of flights with a minimum altitude of 1,500 ft (457 m), which has been shown to avoid most disturbances of waterfowl. Much of the waterfowl hunting is done in spring leads before the survey vessel would arrive. Shell's implementation of its system of Subsistence Advisors and Comm Centers will minimize the chance that any hunts would be disturbed.

4.1.4 Vessel Traffic

Shell's marine survey program involves a single vessel for up to three months. While conducting ice gouge surveys, the vessel would travel at speeds of 4 knots (7.4 km/hr) along up to 621 mi (1,000 km) of survey lines. Additional distances will be traveled when accessing geotechnical borehole locations, but the vessel will be stationary in DP mode during geotechnical operations. Vessel traffic can cause brief behavioral disturbances of fish and wildlife. Disturbance results from visual cues (presence) and audio cues. Sound pressure levels generated various types of survey vessels and the distances at which they attenuate to certain levels and are provided in Tables 4.1.4-1 and 4.1.4-2.

Table 4.1.4-1 Reported Sound Pressure Levels for Vessels during Transit

Vessel	Vessel Power	Activity	Source Level
Fugro Synergy [1]	14,600 hp	Transit 4.5 kt	173.8 dB
Fugro Synergy [2]	9,900 hp	DP Mode	171.3 dB
Ocean Pioneer [3]	5,600 hp	Transit 10 kt	164.9 dB
Ocean Pioneer [4]	5,600 hp	DP Mode	175.9 dB
Nordica	21,000 hp	DP Mode	ND
Nordica	21,000 hp	Transit 12 kt	ND

[1] Broad band back propagated value from measurements in Chukchi Sea for the *Fugro Synergy* in Chukchi Sea Warner and McCrodan (2011)
[2] Source term value in transmission loss equation from measurements in Chukchi Sea for the *Fugro Synergy* in Chukchi Sea Warner and McCrodan (2011)
[3] Best Fit estimate from Chorney et al. (2011) for the *Ocean Pioneer* transiting at 10 knots, based on sound energy in the forward direction in the Burger Prospect, Chukchi Sea
[4] Back propagated source level from Chorney et al. (2011) for the *Ocean Pioneer* in DP mode in the Burger Prospect, Chukchi Sea

Table 4.1.4-2 Reported Distances to Sound Isopleths for Vessels during Transit

Vessel	120 dB		130 dB		140 dB		150 dB		160 dB	
	m	yd	m	yd	m	yd	m	yd	m	yd
Fugro Synergy [5]	1,200	1,312	190	208	28	31	4	4	1	1
Ocean Pioneer [3]	1,100	1,203	230	252	48	52	10	11	2	2
Ocean Pioneer [4]	800	875	190	208	39	43	8	9	2	2
Nordica [6]	2,800	3,062	--	--	--	--	--	--	--	--

[1] Best Fit approach (bow aspect) estimates from Chorney et al. (2011) for the *Mt Mitchell* transiting at 4 knots in the Beaufort Sea
[2] Best Fit approach estimates from Chorney et al. (2011) forward of the *Mt Mitchell* transiting at 10 knots in the Beaufort Sea
[3] Best Fit approach (bow aspect) estimates from Chorney et al. (2011) for the *Ocean Pioneer* transiting at 10 knots in the based on sound energy in the forward direction in the Burger Prospect, Chukchi Sea [4] Best Fit approach forward estimates from Chorney et al. (2011) for the *Ocean Pioneer* transiting at 3.2 knots in the Beaufort Sea
[4] Best Fit estimates from Chorney et al. (2011) for the *Ocean Pioneer* transiting at 10 knots, based on sound energy in the forward direction in the Burger Prospect, Chukchi Sea
[5] Best Fit estimates from Warner and McCrodan (2011) for the *Fugro Synergy* transiting at 4.5 knots, based on sound energy in the forward direction in the Burger Prospect, Chukchi Sea Broad band back propagated value from measurements in Chukchi Sea for the *Fugro Synergy* in Chukchi Sea Warner and McCrodan (2011)
[6] Best Fit estimates from O'Neill and McCrodan (2012)

Impact of Vessel Traffic on Fish and Essential Fish Habitat

Fish have been shown to react when engine and propeller sounds exceeds a certain level (Olsen et al. 1983, Ona 1988, Ona and Godo 1990). Avoidance reactions have been observed in fish such as cod and herring when vessel sound levels were 110-130 dB (Nakken 1992, Olsen 1979, Ona and Godo 1990, Ona and Toresen 1988); however, other have found that fish such as polar cod, herring, and capelin may be attracted to vessels (Rostad et al. 2006). Vessel sound source levels in the audible range for fish are typically 150-170 dB re 1 µPa/Hz (Richardson et al. 1995a). In calm weather, ambient sound levels in audible parts of the spectrum lie between 60-100 dB re 1 µPa. The survey vessel would be expected to produce levels of 170-175 dB when in transit but received sound levels would be reduced to 160 dB within a few yards (meters), and to 120 dB within 800-2,800 m (Table 4.1.4-2). Based on reported source levels for these types of vessels and ambient sound levels of 80-100 dB, there may be some avoidance by fish of the area near Shell's survey vessel. Any avoidance reactions will last only minutes longer than the vessel is at a location, and would be limited to a relatively small area (Mitson and Knudsen 2003, Ona et al. 2007).

There are no commercial or recreational fisheries in the area that could be disrupted by such effects. No especially important spawning habitats are known to occur within the survey. The survey area is at least 3.0 mi (4.8 km) from any anadromous streams or intertidal and subtidal spawning areas that might be used by capelin or herring. The survey area does encompass EFH for salmon, arctic cod, saffron cod, and opilio crab. Although vessel traffic will traverse EFH and could result in brief disturbance of fish, the vessel traffic would have no lasting effect on the habitat. Any impacts from vessel traffic on fish and fish will be negligible, localized, and brief.

Impact of Vessel Traffic on Birds, Threatened and Endangered Birds, and Critical Habitat

Effects of Vessel Disturbance

Vessel traffic can disturb some birds and temporarily displace foraging and resting birds. Some species such as some of the gulls will be attracted to vessels. Disturbances are generally limited to the flushing of birds away from vessel pathways. Larger bird species generally have been found to have greater flushing distances and different types of vessels result in different flushing distances; flushing distances for some waterbird species have been shown to be 66-164 ft (20-50 m) for personal watercraft and 75-190 ft (23-58 m) for an outboard-powered boat (Rodgers and Schwikert 2002). As the survey vessel passes an area, birds would likely move some distance away and then soon after, continue on with foraging and resting. The most commonly encountered birds will likely be Pacific loons, northern fulmars, short-tailed shearwaters, black-legged kittiwakes, glaucous gulls, thick-billed murres, least and crested auklets. In portions of the survey area that are closer to shore, other loon (red-throated loon) and waterfowl (long-tailed ducks, king eider, common eider) species are likely to be more commonly encountered.

Geophysical surveys in the Alaskan Arctic have been monitored previously and found to have little or no effect on birds. Lacroix et al. (2003) investigated the effects of a much larger marine seismic survey involving five vessels on molting long-tailed ducks in the Beaufort Sea and found the survey had no effect on the movements, diving behavior, or site fidelity of the ducks. Shell's planned 2013 Chukchi Sea open water marine survey program involves a single vessel and no airguns.

Effects on bird behavior from Shell's survey vessel will be brief and have a negligible impact on the birds and no impact on bird populations. During the ice gouge surveys, the vessel would travel at slow speeds of 4 knots (7.4 km/hr) or less along survey lines totaling up to about 620 mi (1,000 km). Most of the survey area is located in offshore waters where bird densities are relatively low. Disturbances from offshore vessel traffic should be short term lasting only as long as the activity, and would occur at a relatively small geographic scale. While there is some energetic cost associated with bird disturbance, the brief disturbance expected from vessel traffic associated with the marine surveys would have only negligible effect on birds and no effect on bird populations.

Potential for effects due to vessel incursion is greater near bird nesting colonies where disturbance could result in lowered productivity due to nest abandonment, direct loss of eggs or chicks, increases in predation rates on eggs and chicks, and in important habitats where birds are concentrated for feeding, molting, or staging. Rojek et al. (2007) observed the responses of common murres and Brandt's cormorants at a nesting colony in California to commercial fishing boats. Disturbance of these birds occurred when vessels approached within 660 ft (200 m) of the colony, but most such disturbance consisted of head-bobbing and other alert behaviors. Nearly all the disturbances occurred when vessels approached within 330 ft (100 m) of the colony; 78 percent of the disturbance events occurred when vessels approached to a distance of 164 ft (50 m). The survey area is located more than 100 mi (160 km) from the large cliff nesting colonies in the Cape Lisburne area. Small colonies of arctic terns, glaucous gulls, horned puffins, and common eiders are located on spits and islands shoreward of the survey area; however, the survey area is more than 3.0 mi (4.8 km) from the coastline, thus the vessel traffic associated with the marine survey program would have no effect on nesting colonies.

Effects of Avian Collisions on Birds

Shell's planned open water marine survey program will occur during midJuly to mid-October when many migratory birds are present in the Chukchi Sea. The most common birds in offshore waters during this time frame are Pacific loon, northern fulmar, short-tailed shearwater, black-legged kittiwake, glaucous gull, thick-billed murre, least auklet, and crested auklet. Nearshore waterfowl such as long-tailed ducks, and common and king eiders will be more common. Some of these species tend to fly low over the water (Table 4.1.4-3) placing them at risk of collisions.

Table 4.1.4-3 Average Flight Altitudes of Birds at Northstar Island in Fall 2001-2003

Statistic [1]	Eiders [2]	Loons [3]	Ducks [4]	Shorebirds [5]	Gulls [6]	Alcids [7]
Average	19.7 ft (6.0 m)	28.9 ft (8.8 m)	22.3 ft (6.8 m)	41.4 ft (12.6 m)	63.0 ft (19.2 m)	10.2 ft (3.1 m)
Range	3-164 ft (1-50 m)	3-328 ft (1-100 m)	3-180 ft (1-55 m)	3-213 ft (1-65 m)	3-1,148 ft (1-350 m)	3-33 ft (1-10 m)

[1] Source: Day et al. 2005, Includes visual observations from Northstar with lights on & off, day & night, variable weather
[2] Eiders = king, common Steller's eiders
[3] Loons = red-throated, Pacific, and yellow-billed loons
[4] Ducks = long-tailed duck, American widgeon, northern pintail
[5] Shorebirds = red and red-necked phalaropes, golden plover, semi-palmated sandpiper
[6] Gulls = parasitic jaeger, Herring gull, Glaucous gull, black-legged kittiwake
[7] Alcids = common murre, black guillemot, horned puffin

Growing scientific evidence indicates some bird species are attracted to certain light sources, increasing the risk of bird strikes. Most studies note that increased darkness coupled with inclement weather increases the attraction. Birds drawn to light sometimes become disoriented and collide with these structures. The survey program will be 24-hr operations. There will be 24-hr daylight during much of the surveys but lights may be required in the latter part of the season.

The probability of a bird strike occurring on the vessel is low; however, any strike could result in bird mortality. In four years of monitoring at the Northstar Island facilities in the Beaufort Sea, a total of 39 avian collisions (17 common eiders, four king eiders, four unidentified eiders, and 14 long-tailed ducks) were observed, and sixteen avian collisions (common and king eiders) were reported for Endicott Island in 2001 (Day et al. 2005). These facilities are much larger than a survey vessel, and are located within an area identified as the fall migration route for eiders. No bird strikes were reported during shallow hazards surveys and seismic surveys conducted by Shell in the Chukchi Sea in 2006-2009. Vessel-bird strikes occurred during Shell's 2012 exploration drilling programs in the Chukchi and Beaufort Seas. A fleet of two drilling units and nine support vessels passed through and/or operated in the Chukchi Sea. The support vessels were involved in 45 birds strikes. These included terrestrial passerines such as yellow wagtails and arctic warblers, and waterbirds such as shearwaters, long-tailed ducks, and common eiders.

No avian collisions with the survey vessel are expected to occur during Shell's planned marine survey program. Any avian collision that might occur would likely to result in bird mortality but would not be expected to adversely affect marine bird populations. If an avian collision were to occur it would likely involve more common species such as the long-tailed duck or common eider. Potential for avian collisions will be reduced by mitigation measures, which include the minimization of the use of high intensity lights on the survey vessel, and the shading of lights on the vessel to direct the light downward. Potential impacts from avian collisions are therefore considered minor and short term with any effects mediated by the next year's nesting production.

Effects of Vessel Traffic on Threatened and Endangered Birds and Critical Habitat

Sea ducks appear to be relatively tolerant of vessels in harbor areas of the Alaskan Aleutian Islands (USACE 2000a,b,c). Steller's eiders exhibit tolerance to vessel traffic and seem to readily habituate to vessels and human activity; USACE (2000d) reported that vessels moving through flocks of Steller's eider during arrival to or departure from the Trident Seafood plant dock in the Aleutians do not flush the eiders unless there is direct competition for space, in which case the eider typically flies only a short distance before landing. Tolerance to nearby vessels would reduce any potential impacts on threatened eiders from vessel traffic. Molting flocks of spectacled eiders gather in shallow waters off the coast in water usually less than 120 ft (36 m) deep and travel along the coast up to 31 mi (50 km) offshore (USFWS 2002). However, the density of eiders in areas of the Chukchi Sea would be expected to be relatively low across the survey area (MMS 2007b). Most vessel traffic will occur in offshore areas, where few eiders will be present. Potential effects on these species would be similar to those described above for other marine bird species. Any such effects will be minor as they consist only of behavioral responses, temporary displacement lasting only minutes or hours, and will not involve displacement from habitat that is crucial or restricted in size. The survey area does not include any portions of habitats reported to be particularly important such as Ledyard Bay, Kasegaluk Lagoon, or Peard Bay. Lease Stipulation No. 7 prohibits vessels from entering the LBCHU between 1 July and 15 November. No vessel traffic will occur in the LBCHU (no effect on critical habitat) or in areas such as Peard Bay and Kasegaluk Lagoon where the birds congregate increasing the risk of collisions.

Effects on Kittlitz's murrelets from vessel traffic are mostly behavioral in nature and involve birds immediately flushing away from vessels. Vessel traffic in Glacier Bay, with much higher traffic and Kittlitz's murrelets densities than the Chukchi Sea, was not found to affect the birds energy budget. Densities of Kittlitz's murrelets in the area of vessel activity recovered soon after vessel disturbance ceased (Agness 2006). Any effects of vessel traffic from the marine survey program would be negligible.

Yellow-billed loons may occur in the survey area in relatively low densities during the survey program, with greater numbers likely occurring in more coastal waters. Fischer and Larned (2004) found these loons to be more common in water depths of <33 ft (<10 m) in the Beaufort Sea, while water depths in the survey area are >33 ft (>10 m). Based on the low density of yellow-billed loons in the project area and the use of a single vessel, we estimate that no more than a few yellow-billed loons would be temporarily displaced a short distance, thus vessel traffic will have no or negligible or no effects on individual yellow-billed loons and no effect on the population.

Steller's eider and spectacled eiders, yellow-billed loons, and Kittlitz's murrelet could potentially collide with the vessel; however this is extremely unlikely due to the low densities at which these birds are found in the survey area. The northward migrations of spectacled and Steller's eiders and yellow-billed loons occur before the survey vessel would enter the Chukchi Sea. Bird strikes would be most likely to occur during periods of inclement weather and during non-daylight hours when lights will be used aboard the vessel, during fall migrations. There is almost 24 hours of daylight during July and August and as part of Shell's Bird Strike Avoidance and Lighting Plan, high intensity vessel lights will be shaded or used only when required for safety. While any strike would likely result in injury or mortality to the bird, it have no effect on the

populations. Given the low probability of an avian collision occurring, the potential effects of bird collisions involving threatened and endangered birds is considered negligible.

Impact of Vessel Traffic on Marine Mammals and Threatened and Endangered Marine Mammals

Marine mammals will be present in the Chukchi Sea survey area during the survey, with the most common occurrences likely being ringed seals (threatened), bearded seals (threatened), spotted seals, walrus (candidate), bowhead whales (endangered), and gray whales. Small numbers of ribbon seals, beluga whales, harbor porpoise, killer whales, and minke whales may also be present.

Effects of Vessel Disturbance on Marine Mammals

On Cetaceans: Bogoslovskaya et al. (1981) observed gray whale avoidance behaviors only when vessels came within 980 ft (300 m). Schulberg et al. (1989) reported that many gray whales showed no deflection or change of behavior until vessels came within 98 ft (30 m).

Fraker et al. (1978) observed startle responses in belugas when vessels moved through areas with a high concentration of whales. The amount of avoidance exhibited by an individual beluga is thought to depend on the number of previous exposures, and the level of need for the beluga to be in the area (Finley and Davis 1984). In deep water, belugas may have reacted more intensely to large vessels (Finley et al. 1990; LGL and Greenridge 1986). Scheifele et al. (2005) demonstrated that belugas in the St. Lawrence River increased the levels of their vocalizations as a function of the background noise level (the "Lombard Effect"). Lesage et al. (1993) reported that beluga whales changed their call type and call frequency when exposed to boat noise.

Palka and Hammond (2001) analyzed line transect census data in which the orientation and distance off transect line were reported for large numbers of minke whales. Minor changes in locomotion speed, direction, and/or diving profile were reported at ranges from 1,847-2,352 ft (563-717 m) at received levels of 110-120 dB.

Foote et al. (2004) found increases in the duration of killer whale calls over the period 1977-2003, during which time vessel traffic in Puget Sound, and particularly whale-watching boats around the animals, increased dramatically.

These studies indicate that vessel traffic associated with the marine survey program may result in some disturbance of whales. Cetaceans most likely to be present in the survey area harbor porpoises, belugas, and gray whales. Minke whales and killer whales could be encountered but it is unlikely. Concentrations of gray whales are often seen along the Alaskan Chukchi Sea coast north of Icy Cape, particularly in the Peard Bay area. Gray whales also frequent areas near Hanna Shoal and use the area for feeding (Moore et al. 2000) but Hanna Shoal is located to more than 30 mi (48 km) to the north of the survey area. It is unlikely that vessel traffic will disturb feeding whales or cause avoidance of this area. Vessel traffic may result in temporary deflection of some belugas, particularly in the fall. Behavioral reactions of belugas to vessels would be temporary in nature and localized. Minke whales are unlikely to be encountered but could be similarly affected. Harbor porpoise are known to tolerate ships and may approach moving ships to bow ride (Richardson et al. 1995a). This species is present but not common in the survey area and any impacts from vessel traffic would likely only affect a few individuals. Potential effects of vessel traffic on cetaceans will be reduced by mitigation measures that require the survey vessel to reduce speed and avoid multiple course changes when within 900 ft (274 m) of whales,

avoid separating members from a group, and reduce vessel speed during inclement weather conditions. Effects of vessel traffic on cetaceans will be negligible, with any effects consisting of brief behavioral disturbance and avoidance.

On Pinnipeds*:* Pinnipeds most likely to occur in the survey area during the survey are spotted seals. Ribbon seals could be encountered but it is unlikely. Available data regarding responses of seals to vessels, as well as responses to other noisy human disturbances (Richardson et al. 1995a) suggest that seals often show considerable tolerance of vessels. Seals are not expected to be adversely impacted by sound or the presence of vessels associated with the proposed project. Any impacts of vessel traffic on any seals will be negligible and short term, consisting only of temporary displacement.

Effects of Potential Vessel Strikes on Marine Mammals

It is extremely unlikely that a ship strike of a marine mammal would occur during this project. Most marine mammals actively avoid ships that are under way. Few vessel strikes of whales have been reported in the Chukchi Sea but increased numbers of vessels working in an area does increase the very low likelihood of vessel strikes of marine mammals. George et al. (1994) reported that of 236 harvested bowhead whales examined between 1976 and 1992, two exhibited evidence of past interactions with vessels, and one with questionable scarring. One carcass was reported more recently that appeared to have been struck by a vessel (Rosa 2009). Collisions between ice seals and vessels have seldom been reported. Sternfield (2004) documented only one ice seal stranding in Alaska from 1982 to 2004 that may have resulted from a propeller strike, and that incident involved a spotted seal that took a blow to the skull in Bristol Bay, Alaska. Shell and other operators have operated vessels in the Chukchi Sea since 2006 without any marine mammal strikes.

Shell's survey vessel will have PSOs onboard to assist in spotting marine mammals. PSO observations are reported to the marine crew, who use them to avoid marine mammals and possible vessel strikes. The survey vessel will reduce speed and avoid course changes within 900 ft (274 m) of whales, and vessel speed will be reduced during inclement weather conditions, in order to avoid collisions with any marine mammals. In light of the success of Shell's PSO program during this time period in preventing ship strikes, and Shell's commitment mitigation measures and to continuing the PSO program, it is unlikely that a ship strike of a marine mammal would occur during the survey program. If the very unlikely event of a ship strike occurred, it would impact an individual animal, but would not affect animal populations in the project area.

Effects of Vessel Traffic on Threatened and Endangered Marine Mammals and Critical Habitat

On Polar Bears: Polar bears are known to be attracted to vessels on occasion (Harwood et al. 2005), likely due to curiosity. Brueggeman (1991) reported that polar bears reacted to icebreakers during oil and gas exploration in the Chukchi Sea by walking toward, stopping, looking, and walking/swimming away from the vessel. These reactions, however, were brief and would not be expected to result in any long-term effects. The USFWS (2008) concluded in its Programmatic BO that vessel traffic could result in short-term behavioral disturbance of polar bears or attract animals if in pack ice. USFWS (2012) conducted a thorough review of the effects of vessel traffic associated with oil and gas surveys and found that vessel traffic could

briefly have an energetic cost to a few polar bears but not result in significant disruption of behavior patterns, and would have a negligible impact on polar bear populations.

Shell will implement a polar bear avoidance and interaction plan to mitigate encounters with polar bears. These plans have proven effective in avoiding encounters with polar (and other species) and minimizing the impacts of the few encounters that do occur. As part of Shell's mitigation measures, the survey vessel will not approach closer than 0.5 mi (800 m) to bears observed on land or ice during travel status. With these measures in place any impact on polar bears from vessel traffic will be negligible and temporary, consisting of brief avoidance or attraction responses. There is currently no designated critical habitat for polar bears.

On Threatened and Endangered Whales: The bowhead is the only threatened and endangered whale likely to be encountered during the survey. Fin whales and humpback whales have been reported on a very few occasions in the Chukchi Sea where they are extra-limital, but their occurrence during the survey is very unlikely.

Baker et al. (1982) reported some avoidance by humpback whales to vessel noise at 110-120 dB rms and clear avoidance at 120-140 dB. Frankel & Clark (1998) conducted playback experiments with wintering humpback whales using a speaker producing a low-frequency signal in the 60 to 90 Hz band with output of 172 dB at 3 ft (1 m). For 11 playbacks provided exposures between 120 and 130 dB; there were no measurable differences in tracks or bearings during eight trials but on three occasions, whales either moved slightly away from (n = 1) or towards (n = 2) speaker. Presence of the source vessel had a greater effect than the playback.

Reports of observations of the reactions of bowhead whales to vessels have been variable and somewhat contradictory; however they indicate that vessel traffic will likely result in some temporary avoidance behaviors. When a vessel approaches a bowhead, the most likely response is to swim away from the vessel (Richardson and Malme 1993). Hobbs and Goebel (1982) reported that bowheads react more strongly to boats with outboard motors than to diesel ships. Richardson and Finley (1989) noted that bowheads tend to react most strongly to vessels when the vessels were moving quickly and directly toward the whale than if the vessel was moving more slowly or in any other direction than at the whale.

Richardson et al. (1985b) reported that bowheads reacted more strongly to vessel traffic than aircraft overflights and drilling, with most turning away when vessels came within 0.6-2.5 mi (1-4 km). Whales typically tried to outrun the boat; when the vessel was within a few hundred yards (meters); the whales turned away from the vessel path or dove. Groups of whales scattered; fleeing generally stopped a few minutes later but scattering was evident for perhaps an hour or more. Additional responses to vessels included changes in respiration rates. Similar responses to vessels have been observed in fin (Ray et al. 1978 in Richardson et al. 1985b) and humpback whales (Baker et al. 1983 in Richardson et al. 1985b).

Koski and Johnson (1987) made similar observations of bowheads in the Alaskan Beaufort where strong responses by feeding bowheads to large icebreakers and supply vessels were observed. On two occasions, a support vessel passed within 0.6-1.9 mi (1.0-3.0 km) of the whales, all of which moved directly away from the vessel, some as far as 2.5-3.7 mi (4.0-6.0 km). Changes in whale behavior were temporary, with feeding often resuming while the moving vessel was still within 3.7-6.0 mi (6.0-10.0 km). At least some of the whales were observed back at the same area the next day indicating there was little if any effect on use of the area by whales.

Wartzok et al. (1989) reported that bowheads generally ignored a small ship at distances greater than 1,640 ft (500 m). Over 180 whales voluntarily approached within 1,640 ft (500 m) of the vessel. Little response was noted unless there was a sudden change in sound level due to ship acceleration.

These studies indicate that bowheads within 0.6-2.5 mi (1-4 km) of the survey vessel may alter their behavior. Any resulting changes in behavior such as swimming speed and orientation, respiration rate, surface-dive cycles will be temporary and lasting only minutes or hours. Similarly, any consequent displacement of bowheads will be of a similar length of time and be restricted to a distance of a few miles (kilometers) from the vessel (Richardson et al. 1995). The survey vessel will not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete so few bowheads are expected to be encountered. Fall migrating bowheads could encounter the survey operations as they move south to the Bering Sea wintering grounds, or west across the Chukchi Sea to feeding areas along the Russian coast. Given the widespread nature of the migration route, displacement of whales by vessel traffic is unlikely to have more than a temporary effect on bowhead behavior and no lasting impacts on individuals or the population. When underway, the survey vessel must reduce speed, avoid separating members from a group of whales and avoid multiple course changes when within 300 yd (274 m) of whales. Vessel speed will also be reduced during inclement weather conditions in order to avoid collisions with marine mammals. With these mitigation measures in place, any effects on bowheads or other endangered whales from vessel traffic will be minor and temporary, lasting only minutes or hours after the vessel has passed.

On Ringed Seals, Bearded Seals, and Walrus: Walrus reactions to ships include waking up, head raises, and entering the water (Richardson et al. 1995a). Reaction distance depends on ship speed, and is likely influenced by sight of the ship as well (Fay et al. 1984). Walrus in open water appear less responsive than those on ice, showing little reaction unless the ship is very near to the animals (Fay et al. 1984). Brueggeman et al. (1990, 1991) reported that no observed groups of walrus observed during a Chukchi Sea monitoring program exhibited escape behavior in response to anchored or drifting vessels; responses of walrus to moving vessels ranged from nothing to approaching the vessel to escape behavior, and varied with distance (Table 4.1.4-4); most reactions occurred when the vessel came within about 550 yd (500 m) of the walrus. Salter (1979) reported no detectable response by walrus at a terrestrial haulout site to approach by outboard motorboats at distances of 1.1-4.8 mi (1.8-7.7 km). For walrus hauled out on ice the probability and type of reaction depended on distance (Brugeggeman 1990, 1991, 1992).

Table 4.1.4-4 Walrus Reaction to Transiting Vessels in the Chukchi Sea

Vessel-Walrus Distance [1]	Number of Walrus Groups Exhibiting Response by Distance [1,2]							
	None		Approached		Head Raise		Escape	
	1989	1990	1989	1990	1989	1990	1989	1990
0.0-0.14 m (0.0-0.23 km)	3	4	0	1	0	-	4	3
0.14-0.28 mi (0.23-0.46 km)	2	11	0	0	0	-	4	1
0.28-0.58 mi (0.46-0.93 km)	0	33	0	1	0	-	2	1
>0.58 mi (>0.93 km)	0	18	0	0	0	-	1	1

[1] Brueggeman et al. 1990, 1991
[2] Number responding out of 16 observations in 1989 and 74 observations in 1990

Ringed and bearded seals appear to be fairly tolerant of vessel traffic. Brewer et al. (1993) reported observations of ringed seals following ice management vessels in the Beaufort Sea,

apparently feeding on fish and plankton in the disturbed waters. Blees et al. (2010) reported that the most common reaction of seals (ringed and bearded) to seismic survey monitoring vessels near Burger Prospect were looking at the vessel (63 percent) and no reaction (39 percent), while about nine percent exhibited reactions of increasing swim speed, changing direction, or splashing. Available data and reported responses of seals to vessels as well as to other noisy human disturbances (Richardson et al. 1995a) suggest that seals often show considerable tolerance of vessels.

Ringed seals, bearded seals, and walrus will be present in the survey area during the survey, but impacts of vessel traffic on any of these marine mammals will likely be minor and short term, consisting only of temporary displacement. In general, seals and walrus may leave the ice, make hasty dives or move away from the area. Brueggeman et al. (1991) noted that the behavioral effect on walrus was very brief, with displaced walrus occasionally re-occupying ice floes as soon as the vessel passed. Potential effects of vessel traffic on walrus will be reduced with implementation of mitigation measures that prohibit the survey vessel from operating within 0.5 mi (800 m) of walrus when observed on land or ice. Given these mitigation measures and pinniped tolerance of vessels, any impacts of vessel traffic on any of these marine mammals will be minor and short term.

Impact of Vessel Traffic on Sensitive Resources

None of the identified sensitive resource areas in the Chukchi Sea are located in the survey area. Therefore no vessel traffic is expected in these areas. Lease Sale 193 Stipulation No. 7 prohibits Shell and other operators from transiting the LBCHU with vessels between July 1 and November 15 except in emergencies.

Impact of Vessel Traffic on Subsistence

Effects of Vessel Traffic on Bowhead Whale Hunting

Residents of Wainwright, Point Lay, and Point Hope hunt bowheads primarily open leads in the ice from late March or early April until the first week of June. Shell's operations will commence in mid-July so the survey program would have no impact on these whaling subsistence activities.

Barrow residents also hunt bowheads in the fall but nearly all fall-harvested whales are harvested east of Point Barrow in the Beaufort Sea, so there is no opportunity for survey area vessel traffic to affect Barrow fall whaling. Barrow crews sometimes harvest fall whales in the Chukchi Sea (Suydam et al. 2008) but it is unlikely that survey vessel traffic could impact the hunt as it would likely occur north of the survey area and above the survey area with regards to the whale migration route.

Wainwright has hunted in the fall as well in recent years, harvesting the first fall bowhead by a northeastern Chukchi Sea village in over 90 years, in October 2010 offshore of Point Franklin north of Wainwright. The survey area encompasses areas where fall whaling may be conducted by Wainwright. Shell's has mitigation measures in place to avoid any impacts to fall whaling. These measures include Subsistence Advisors, Community Liaisons, and Com Centers. Given these measures, vessel traffic is likely to have no or negligible effect on fall whaling in the Chukchi Sea.

Effects of Vessel Traffic on Beluga Whale Hunting

The Point Lay beluga hunt is concentrated in late June or the first two weeks of July (but sometimes continues into August), when belugas are herded by hunters with boats into Kasegaluk Lagoon. Point Hope hunters primarily harvest beluga in conjunction with spring bowhead hunts in late March and early June, but continue to hunt them in open water along the coast from late July through early September. The survey area is located north of the areas where Point Hope and Point Lay hunt beluga while migratory movements of belugas during spring and summer tend to be from south to the north. Additionally, the marine survey program will be conducted after the date when most hunts are complete. Given these factors the survey program is expected to have no effect on the Point Hope or Point Lay beluga hunts. Barrow residents occasionally hunt beluga in coastal waters in July-August; however, interviewed local hunters reported that belugas have not been commonly hunted by Barrow residents in recent years (Sound Enterprises and Associates 2008). Wainwright residents hunt beluga during the spring, but the primary beluga hunt occurs during July and August in coastal waters from Icy Cape to Point Franklin, which lie partially within the survey area.

Sound energy from vessel traffic could potentially cause brief disruption to beluga whale harvest but not make the resource unavailable to subsistence users (MMS 2008a). Beluga whales respond differentially to vessel sound energy (see discussion above), but temporary and localized sound energy from vessels should cause only brief disturbances to the whales. These disturbance effects have duration of one day or less (MMS 2008a). The Alaska Beluga Whale Committee believes that Wainwright vessels / barges interrupted beluga hunts in 2007 and 2009 (ABWC 2011). Shell will use its system of SAs and Com Centers to minimize any potential effects on these beluga hunts. Survey operations can be trans-located to portions of the survey area located far offshore, or work in the Beaufort Sea, when beluga hunts are on-going. Given these measures, survey vessel traffic would be expected to have negligible effect on Wainwright and Barrow beluga hunts.

Effects of Vessel Traffic on Polar Bear Hunting

Point Lay and Point Hope hunters usually harvest polar bears in January-April and within about 10 mi (16 km) of the community (USFWS 2012). Vessel traffic associated with the open water marine survey program would therefore have no opportunity to affect polar bear hunting by Point Hope or Point Lay residents. Most recent polar bear harvests reported by Barrow have occurred in February and March (USFWS 2012). Wainwright harvests polar bears throughout much of the year, with peak harvest reported in May and December within 10 mi (16 km) of the community (USFWS 2012). Survey vessel traffic will therefore have very limited opportunity to affect polar bear hunting by Barrow or Wainwright residents. BOEM concluded that vessel traffic is unlikely to affect polar bear availability for subsistence (MMS 2008a). Shell anticipates no impact to subsistence polar bear hunting from survey vessel traffic.

Effects of Vessel Traffic on Seal Hunting

The survey area is located north of areas typically utilized by Point Hope and Point Lay residents for seal hunting; however, nearshore portions of the survey area are used by residents of Wainwright and Barrow for hunting seals. Barrow residents harvest many of their seals in the winter, but spotted seals especially are hunted throughout the open water period. Wainwright residents hunt ringed seals most intensively in May-July but hunt other times as well. Spotted seals are hunted throughout the open water period.

Thus there is potential that vessel activity associated with the marine survey program could impact subsistence hunting for seals. Ringed seals make up the bulk of the seal harvest, but bearded seals, and spotted seals are harvested in large numbers as well.

Disturbances of seals could potentially affect the hunt by making the seals less available or more wary, but BOEM has concluded vessel traffic would not cause long-term effects on seal distribution or availability for subsistence (MMS 2008a). Seals appear to be relatively tolerant of vessels, but vessel traffic can result in seals leaving the ice or terrestrial haulouts, making hasty dives, or moving away (MMS 2008a). However, most of the survey area is located offshore of where seal hunting is conducted. Mitigation measures, including the establishment of a system of Subsistence Advisors and Com Center, will be used to minimize any potential impacts to seal hunting. Given these mitigation measures, there will likely be no, or negligible, effects on seal hunting from survey vessel traffic.

Effects of Vessel Traffic on Walrus Hunting

The survey area is located north of areas utilized by Point Hope and Point Lay residents for hunting walrus so vessel traffic associated with the survey program would have no effect on these hunts. Walrus are harvested by Barrow residents in conjunction with the spring bowhead hunt in the Chukchi from Point Barrow to Peard Bay, but the primary effort occurs from late June to mid-September with a peak in August. Wainwright residents hunt walrus in July-August along the retreating ice pack but occasionally harvest walrus hauled out on the beaches in August and September. Nearshore portions of the survey area are used by residents of Wainwright and Barrow for hunting walrus. Although a portion of the walrus harvest occurs in the spring prior to when the survey vessel would arrive in the Chukchi Sea, some walrus hunting is conducted throughout the summer and could be impacted by the survey vessel in transit or when conducting survey operations. Any such effects would be temporary and minor as a single survey vessel will be used in the Chukchi Sea for only part of the season. Mitigation measures, including the establishment of a system of Subsistence Advisors and Com Center, will be used to minimize any potential impacts to seal hunting. Given these mitigation measures, there will likely be no or negligible effects on walrus hunting from survey vessel traffic.

Effects of Vessel Traffic on Fishing

Areas used by residents of Point Hope and Point Lay are located to the south of the survey and along the coast. Most fishing by Barrow residents is conducted at inland fish camps, but coastal fishing can be important and takes place along the Chukchi Sea coast from Barrow south to Walakpa Bay (Craig 1989b). in the spring and summer in conjunction with hunts for waterfowl and marine mammals. No survey vessel traffic would be expected to occur in or near these fishing areas, so vessel traffic would therefore have no effect on subsistence fishing by Barrow, Point Hope, or Point Lay residents.

Wainwright residents conduct some subsistence fishing in marine environments along the shoreline, and in lagoons and estuaries. Fishing is conducted in the summer along the coast from Peard Bay to Icy Cape and in the Kuk Lagoon. Gill nets are set in the inlet near the village and ocean gill nets are set about 150 ft (50 m) from shore. Pink and chum salmon are captured in the ocean while the inlet yields rainbow smelt, whitefish, cisco and Arctic and saffron cod. Fishing by Wainwright residents is not known to occur in Federal waters of the OCS where Shell's survey area is located. Vessel traffic would therefore not be expected to occur in or near any fishing area or have any effect on subsistence fishing by Wainwright residents.

Effects of Vessel Traffic on Bird Hunting and Egg Collection

These resources compose a small (2-5 percent, Table 3.11.7-2) but important part of the total subsistence harvest (ACI et al. 1984). Harvests occur throughout the spring, summer, and fall, both inland and in or adjacent to coastal waters, and often in conjunction with hunts for marine mammals. Portions of the survey area are used for waterfowl hunting by residents of Wainwright and Barrow. Vessel traffic has the potential to disturb (flush) birds, but the effects on the birds would be minor and temporary resulting in no long term change in bird distribution, density, or other aspect of availability for subsistence. Hunts could be affected if the survey vessel actually transited through the area being hunted. The chance of this occurring is low as most of the survey area is offshore of areas used for waterfowl hunting and because much of the waterfowl hunting is done in spring leads before the survey vessel would arrive. Shell's implementation of its system of Subsistence Advisors and Com Centers will minimize the chance that such effects would occur. Given the location and timing of the marine survey program and the mitigation measures, vessel traffic associated with the open water marine survey program would have no, or only negligible, effects on bird hunting.

4.1.5 Geotechnical Coring

The primary effects associated with geotechnical coring will be disturbance of the seafloor by the coring equipment and removal of the sediment cores. Estimates of the area of seafloor that would be affected by impact of the coring equipment are provided in Table 4.1.5-1.

Table 4.1.5-1 Seafloor Area that may be Directly Affected by Geotechnical Borings

Geotechnical Method	Single Borehole Location		All Borehole Locations	
Seabed drilling system [1,2]	186 ft^2	17.3 m^2	5,213 ft^2	484 m^2
Jumbo piston corer / CPT system [3]	0.08 ft^2	0.01 m^2	7.1 ft^2	0.7 m^2

[1] Assumes a single run at each of 28 borehole locations with a borehole diameter of 4.0 in (101 mm)
[2] Area includes the borehole (0.9 ft^2 / 0.008 m^2 per boring, 2.41 ft^2 / 0.2 m^2 per all borings) and area under the deck and legs (186.1 ft^2 / 17.3 m^2 per boring, 5,213 ft^2 / 484.3 m^2 per all borings)
[2] Assumes three runs at each of the 28 borehole locations, one with the corer and two companion runs with a CPT, all with a diameter of 4.0 in (100 mm)

Effects on the seafloor from coring and CPT are limited to the impact of the corer/CPT itself on the seafloor, the core is removed from the core barrel on the vessel and saved for laboratory analysis. Rotary drilling by the seabed drilling system would generate drill cuttings (Table 4.1.5-1), wheras the jumbo piston corer/CPT system does not. Ambient seawater is pumped down the center of the drillstem, out the drill bit, and carries the cuttings from the drill bit to the seafloor surface where they are discharged to the water column via an eductor system. Discharged cuttings would be re-deposited on the seafloor in the immediate vicinity of the borehole. Estimates of the area of seafloor that might be affected by deposition of the cuttings are provided in Table 4.1.5-3.

Table 4.1.5-2 Cuttings that may be Generated by Rotary Drilling

Unit	Per Boring		For All Borings	
Seabed drilling system	2.1 ft^3	0.06 m^3	59.4 ft^3	1.7 m^3

[1] Assumes a total of 28 borings, each 50 ft (15.2 m) deep, drilled with a seabed drilling system with a diameter of 4.0 in (101 mm)

Table 4.1.5-3 Seafloor Area that may be Affected by the Deposition of Cuttings

Average Deposition Thickness [1]		Single Borehole Location [2]		All Borehole Locations [4]	
1.0 in / 2.5 cm	Radius	2.8 ft	1.2 m	--	--
	Area	25.4 ft^2	4.8 m^2	712.5 ft^2	66.2 m^2
2.0 in / 5.1 cm	Radius	2.0 ft	0.9 m	--	--
	Area	12.7 ft^2	2.4 m^2	356.3 ft^2	33.1 m^2
3.0 in / 7.6 cm	Radius	1.6 ft	0.7 m	--	--
	Area	8.5 ft^2	1.6 m^2	237.5 ft^2	22.1 m^2

[1] Assumed deposition thickness for estimation of areal coverage – not results of modeling
[2] Assumes maximum depth of 50 ft and a single run at each of 28 borehole locations with discharge volumes in Table 4.1.5-2

Impact of Geotechnical Coring on Water Quality

Geotechnical coring will disturb seafloor sediments and potentially result in the discharge of drill cuttings if the seabed system rotary drilling method is used. Some of the disturbed sediments and discharged cuttings will be suspended in the water column during these operations. About 02.1 ft^3 (0.06 m^3) of cuttings would be discharged along with seawater at the site of each borehole if rotary drilling is conducted with the seabed drilling system. A portion of the fine sediments within these cuttings would be suspended in the water column resulting in a plume with increased total suspended solids (TSS), turbidity, and biochemical oxygen demand (BOD). The primary effect of the discharge will be increased TSS, with most of this effect ameliorated within a short distance of the discharge locations through settling and dispersion. Impacts to water quality would cease when the discharge is concluded. TSS loading in the plume would be expected to be less than 1,000 ppm and could be less than 300 ppm (LaSalle et al. 1991). Construction work in the Beaufort Sea has been shown to result in incremental TSS loads of 200-600 ppm (Slaney 1977, Envirocon 1977), but these loads were reduced to 14-100 ppm within about 1,640 ft (500 m) away from the discharge point. These increased sediment loads would be restricted to a very small area and would be expected to remain suspended for a very short time. Much less material would be introduced in the water column from geotechnical coring. Any impacts to water quality from the proposed geotechnical coring would be negligible and temporary lasting only minutes after the coring operations is complete.

Coring operations using the jumbo piston coring / CPT system would result in only negligible effects on water quality. Some sediment would be disturbed and small volumes of these sediments would enter the water column on impact of the jumbo piston corer. Associated CPT operations would have no effect on water quality.

Impact of Geotechnical Coring on Seafloor Sediments

Direct disturbance of the seafloor sediments from geotechnical coring will be limited to the surface area of the boreholes and placement of the equipment on the seafloor (Table 4.1.5-1). Additional seafloor area will be indirectly impacted by the deposition of drill cuttings from any rotary drilling (Table 4.1.5-3). The physical effects would be restricted to a very small portion of the Chukchi Sea seafloor, with a total area of about 7.1-5,926 ft2 (0.7-619 m2) of seafloor being directly or indirectly disturbed. The physical manifestations of these activities will attenuate naturally over time by the natural movement of seafloor sediments and ice scours. Duration is therefore dependant on water depth, currents, characteristics of the seafloor sediments, and the frequency of ice gouging and sediment disturbance by biota such as gray whales, walrus, and benthic infauna. Surficial sediments in the area consist of sandy mud and gravel which are continuously reworked by currents, storms, ice gouging, and biota. Because the cuttings consist

only of shallow sediments from the same location there would be no contamination or other long term effects. These impacts are considered negligible and short-term.

Impact of Geotechnical Coring on Lower Trophic Organisms

Benthic organisms within the area directly affected by geotechnical coring would likely be destroyed by the drill bit, piston corer, or CPT, with either geotechnical technology. However, borehole diameters will be only about 4.0 in (100 mm) so the total area directly disturbed would be exceedingly small – on the order of 2.4-7.1 ft^2 (0.2-0.7 m^2) for all 28 borehole locations. If the seabed drilling system is utilized, benthic organisms would also likely be crushed within the area of seafloor occupied by the frame of the system, which weighs about 22,046 lb (10 tonnes) and consists of a deck and protruding legs/pads that stabilize it. The total area (Table 4.1.5-3) that would be directly affected would be about 7.1-5,213 ft^2 (0.7-484 m^2).

If the seabed drilling system is used, benthic organisms within an additional area surrounding each borehole may be smothered by drill cuttings. There is relatively little information on the effects of various deposition depths on arctic biota (Dunton et al. 2003, Hurley and Ellis 2004). Burial with dredged sediments to depths as low as 1.0 in. (2.54 cm) have been found to be lethal for some benthic organisms (Wilber 1992, EPA 2006). Deposition of the drill cuttings to depths of 1.0 in. (2.5 cm) or more could therefore be expected to smother and kill benthic organisms in the vicinity of the borehole. We estimate that a total area of about 712 ft^2 (66.2 m^2) of seafloor would be indirectly affected by the deposition of drill cuttings if rotary drilling as conducted to depth in all 28 boreholes. Benthic organisms within this area may be smothered and killed. The seafloor area that would be disturbed would be small. Seafloor severely disturbed by ice gouging in the high Arctic have been found to be largely re-colonized within eight to nine years (MMS 2007b). Given that these indirect effects are not as severe as ice gouging, and that the cuttings would consist of shallow sediments from the same location, the habitat would not be expected to change greatly and re-colonization by the original benthic community would be expected to occur much more quickly The effects on benthic organisms would be minor based on the small total area of direct and indirect seafloor disturbance and short term with re-colonization relatively quickly. No especially important or sensitive benthic communities are known to occur within the survey area. Kelp beds have been reported to occur in water depths of 36-43 ft (11-13 m) south of the survey area, and in similar water depths near Skull Cliffs north of Peard Bay and the survey area (Phillips and Reiss 1983 1985a, 1985b;, Phillips et al. 1982), just shoreward of the survey area. Boreholes are not planned for these areas.

Discharge of the drill cuttings could potentially impact phytoplankton by increasing TSS loads in the water column and increasing turbidity. However, the discharges of cuttings and drilling fluids will occur at the seafloor at very low rates. The discharges should therefore not result in any measureable effects on phytoplankton, which occur primarily in the upper photic zone of the water column while the discharges and most of the physical effects such as turbidity will occur at the seafloor and lower portion of the water column. The fine-grained particulates and other solids in drill cuttings could cause sub lethal effects to zooplankton in the lower portion of the water column. Zooplankton in the immediate area of discharge from geotechnical operations could be adversely impacted by sediments in the water column, which could clog respiratory and feeding structures. However, any such impacts would be negligible affecting a very small area (<0.00000008% of the Chukchi Sea) and short term, lasting only about as long as the geotechnical operation.

Impact of Geotechnical Coring on Fish and Fish Habitat

Coring with the piston corer or CPT would have no direct effect on fish. If rotary drilling is conducted with the seabed drilling system, fish larvae and eggs could potentially be impacted in the water column by the suspended drill cuttings (sediments), or on the seafloor as the cuttings are deposited.

The effects of suspended sediments is dependent on the species of fish, their life stage (eggs, larvae, juveniles, and adults), the concentration of suspended sediments, the type of sediment, and duration of exposure (IMG-Golder Corporation 2004). Eggs and larvae have been found to exhibit greater sensitivity to suspended sediments (Wilber and Clarke 2001). This sensitivity is related to their relative lack of motility (Auld and Schubel 1978) and surficial membranes that are especially susceptible to abrasion (Cairns 1968). Boehlert and Yoklavich (1984) reported severe abrasion and puncture damage to herring eggs at suspended sediment loads as low as 4,000 ppm. Wilber and Clarke (2001) reported delayed hatching success after exposure of eggs to 1,000 ppm for one day, and 25 percent mortality after exposures of 1-3.5 days. Adhesive demersal eggs could be exposed to the sediments as long as the activity continues, while pelagic eggs exposure would be much shorter as they move with ocean currents. The deposition of the cuttings on the seafloor could smother demersal fish eggs; however, some of the more numerically and ecologically important marine fish species (e.g. arctic cod) in the northeastern Chukchi Sea spawn under the ice during the winter (Craig 1984) and have floating eggs, and would therefore not be affected.

Juvenile and adult fish have been shown to avoid areas with increased TSS loads (Messieh et al. 1981, Wildish and Power 1985, Boubée et al. 1997), but fish are also known to return shortly after such disturbances (Courtenay et al. 1980, Holland et al. 1980). TSS loads in dredge plumes are usually less than 1,000 ppm and are often less than 300 ppm (LaSalle et al. 1991); dredging efforts in the Canadian Beaufort (Slaney and Company Limited 1977, Envirocon 1977) resulted in TSS loads of 200-600 ppm, but these loads were reduced to 14-100 ppm within 1,640 ft (500 m). These suspended sediment concentrations would not be expected to impact juvenile or adult fish, which can generally withstand TSS loads of more than 1,000 ppm without lethal or sub lethal effects, and which have been shown to avoid plumes of suspended sediments. Geotechnical operations at any location area expected to be completed in less than 24 hours, so any water column effects will be ephemeral. Suspension of sediments through the discharge of drill cuttings and subsequent deposition would therefore be expected to have little effect on juvenile or adult fish.

A total of about 7.1-5,926ft^2 (0.7-618.9 m^2) of seafloor fish habitat would be directly or indirectly affected. The impacted areas would be within portions of the Chukchi Sea identified by NOAA as EFH for opilio crab, arctic cod, and saffron cod. Within areas indirectly impacted by the discharges, the existing seafloor sediments would be covered / replaced by cuttings. Sediment texture and seafloor relief would be altered only slightly due to the small volume of cuttings and the fact that the cuttings are shallow sediments from the same locale. Benthic organisms that fish may feed on would be crushed or smothered within this area. These habitat effects would be ameliorated over time by physical (currents, storms, ice gouging), chemical (oxidation), and biological (biodegradation, bio-turbation) processes, and re-colonization by the original benthic community. Ice gouging and the effects of storms and currents would be greater in nearshore areas than farther offshore. About 24 percent of the Chukchi Sea seafloor is disturbed each year by walrus and gray whale (Nelson et al. 1994). Most habitat effects would

be expected to be ameliorated within a few years. The area impacted in this fashion would represent less than 0.00000008% of the Chukchi Sea. Although located within EFH, no special fish habitats such as especially productive areas, spawning areas, or hard bottoms are known to occur within the survey area. The only known kelp beds in the northeastern Chukchi Sea are located shoreward of the survey area and would not be affected by geotechnical coring. Effects on fish habitat would be restricted to a very small area, and would be negligible and short term.

Analysis of Impact of Geotechnical Coring on Birds

Geotechnical coring would have no direct effects on birds. There will be some physical habitat alteration and destruction of benthic organisms that could result in negligible indirect effects on birds. If the jumbo piston core / CPT system is used, the habitat impacts would be restricted to the very small area of the core itself, a total of about 7.1 ft^2 (0.7 m^2). If the seabed drilling system is used and rotary drilling is conducted, habitat impacts will include the borehole, the placement of the heavy seabed drilling system on the seafloor, and the deposition of cuttings on the seafloor in the immediate vicinity. A total of 5,211 ft^2 (484 m^2) would be directly or indirectly affected by the seabed drilling system. Some bird species that feed on benthic invertebrates, such as eiders and other sea ducks, utilize the portions of the survey area, could thus be indirectly affected; however, the effects would be minor due to the small percentage of the available habitat that would be affected. These effects on bird habitat would be short term with re-colonization of the disturbed areas occurring in a relatively short time period, and negligible (<0.00000008% of the Chukchi Sea).

Effect of Geotechnical Coring on Threatened and Endangered Birds and Critical Habitat

Geotechnical coring would have no effect on Steller's and spectacled eiders and negligible effect on the habitat. Steller's and spectacled eiders are benthic feeders so seafloor disturbance and destruction of benthic organisms could have some indirect effect on these species. A total of up to 5,926 ft^2 (618.9 m^2) of benthic habitat could be directly or indirectly affected, but these indirect effects on bird habitat would be negligible due to the small percentage of the available habitat that would be affected and short term with re-colonization of the disturbed areas occurring in a relatively short time period. No borehole locations are located within the LBCHU or other areas that the birds are known to use regularly, such as Peard Bay and Kasegaluk Lagoon. Geotechnical coring will have no effect on critical habitat for Steller's or spectacled eiders.

Any effects on Kittlitz's murrelets and yellow-billed loons from geotechnical coring will be negligible. Only temporary displacement from the vessel will occur and that is unlikely given the low density of these birds in the survey area. These species are not benthic feeders so seafloor disturbance will have no direct effect on feeding or foraging habitat.

Analysis of Impact of Geotechnical Coring on Marine Mammals

The impacts on marine mammals from geotechnical coring will be negligible. The vessel will be stationary when conducting geotechnical coring, and held on station with DP. Thus there will be no anchoring or mooring of the vessel. Some temporary displacement, the only direct effect on marine mammals, may occur. Effects associated with the displacement will consist only of brief behavioral responses such as the animal moving away or avoiding the area.

Gray whales, belugas, spotted seals, and other marine mammals will likely avoid the coring activities because of the proximity to the vessel, and not come into close contact with the turbidity plume created by the discharge of cuttings. Effects of vessel presence are discussed

elsewhere. There will be some physical habitat alteration and destruction of benthic organisms that could result in negligible indirect effects on benthic feeding marine mammals. If the jumbo piston core / CPT system is used, the habitat impacts would be restricted to the very small area of the core itself, a total of about 7.1 ft^2 (0.7 m^2). If the seabed drilling system is used and rotary drilling is conducted, habitat impacts will include the borehole, the placement of the heavy seabed drilling system on the seafloor, and the deposition of cuttings on the seafloor in the immediate vicinity. A total of 5,926 ft^2 (618.9 m^2) would be directly or indirectly affected by the seabed drilling system. Gray whales are benthic feeders and the area of seafloor that will be covered by discharge will be unavailable to the whales for foraging purposes. This is not expected to impact individual whales or the gray whale population, because the areas of seafloor disturbance is so small compared to the total area available to the whales for foraging, and are not of any special importance. Any effect on the seafloor as foraging area for benthic feeding marine mammals such as gray whales would be negligible and temporary. Most of the other marine mammal species found in the survey area such as spotted seals, beluga, minke whale, and harbor porpoise are not known to rely heavily on benthic organisms, and because of the small area of seafloor likely to be affected. Any indirect effects from the discharge on forage species for these marine mammals would be negligible due to the small area of effect (<0.00000008% of the Chukchi Sea).

Effect of Geotechnical Coring on Threatened and Endangered Marine Mammals and Critical Habitat

On Polar Bears: Geotechnical coring would have no impact on polar bears. Geotechnical coring would take place within habitat for polar bears but would have negligible effect on the sea ice habitat which is sea ice over waters that support adequate prey resources. The geotechnical coring would have no effect on sea ice and no effect on the overall abundance of the principal prey species (ringed seal and bearded seal).

On Threatened and Endangered Baleen Whales: Threatened and endangered whales in the Chukchi Sea include the bowhead, humpback, and fin whale. Geotechnical coring would have no direct effect on these species. As with other marine mammal species discussed above, the vicinity of the vessel would likely be avoided because of the sound generated by the vessel and human activity. Although bowheads sometimes forage on the seafloor these species are not generally considered benthic feeders, so indirect habitat effects would be negligible.

On Ringed Seals, Bearded Seals, and Walrus: Ringed seals, bearded seals, and walrus will likely be present in the survey area when survey operations are on-going. However, geotechnical coring would be expected to have no impact on these species. Bearded seals and walrus are benthic feeders, and geotechnical coring would likely result in the destruction or alteration of benthic habitats and organisms, but the area involved is very small (<0.00000008% of the Chukchi Sea). A total of 5,926 ft^2 (618.9 m^2) could be directly or indirectly affected. Benthic invertebrates within these areas will be destroyed or smothered, but the site would likely be re-colonized in a relatively short time period.

Impact of Geotechnical Coring on Sensitive Resources

None of the identified sensitive resource areas are located within the survey area. Geotechnical coring will have no effect on these sensitive resource areas.

Impact of Geotechnical Coring on Subsistence

The effects of the presence of the survey vessel on subsistence are addressed above under the *Impacts of Vessel Traffic on Subsistence* and the effect of the sound energy generated by the geotechnical equipment on subsistence are addressed above under the *Impacts of Sound Generation by Geophysical and Geotechnical Equipment on Subsistence* The primary physical effects of the geotechnical coring operation itself will be disturbance of the seafloor, creation of a plume in the water column with increased TSS, and deposition of the cuttings on the seafloor. The primary potential effect that this could have on subsistence is the deflection and displacement of subsistence resources (marine mammals and waterfowl). However, the physical impacts will be manifested only in a very small area in the vicinity of the survey vessel, and will likely be limited to the area from which marine mammals and birds have already been displaced due to vessel presence and sound energy generated by operation of the vessel and geotechnical equipment. Thus geotechnical coring is not likely to result in any incremental increase in potential effects on subsistence. The reader is referred to the above-referenced sections of the ER for a more detailed analysis of these potential effects.

Geotechnical coring will be conducted in the nearshore portions of the survey area in mid-July to mid-October in areas used by residents of Wainwright for hunting bowheads, belugas, seals, and waterfowl in the summer and fall. Most of the 28 planned boreholes are expected to be located offshore of subsistence areas. Only a small number of the geotechnical boreholes will be located in areas known to be used for these subsistence activities, and the geotechnical operations are expected to be completed within 24 hrs at each location. Shell will use its system of Subsistence Advisors, Com Centers to avoid conducting geotechnical operations in areas of active subsistence. Given these measures, geotechnical coring is likely to have no or negligible effect on subsistence in the Chukchi Sea.

4.1.6 Geophysical and Geotechnical Sound

Acoustical equipment that will likely be used during the 2013 open water survey program includes side scan sonar, single-beam and multi-beam bathymetric sonar, sub-bottom profiler, and USBA. These types of equipment have been used in past survey programs in the Chukchi Sea and the sound energy generated by their use was characterized as part of required monitoring programs. Some of these data are provided below in Tables 4.1.6-1, 4.1.6-2, and Table 4.1.6-3.

Table 4.1.6-1 Geophysical Equipment Sound on the *Fugro Synergy* in the Chukchi Sea

Source Type	Frequency	Radial Distance (m) to Sound Energy Isopleths							
		120 dB	130 dB	140 dB	150 dB	160 dB	170 dB	180 dB	190 dB
Single beam echosounder	200 kHz	72	55	43	33	26	20	15	12
HiPAP (USBA)	22/23 kHz	370	140	52	20	7	3	1	--
Ship sound in transit	--	1,200	190	28	4	1	--	--	--

[1]Warner and McCrodan, 2011
µPa – micropascal
dB – decibel

Table 4.1.6-2 Sound from Geophysical Equipment on the *Ocean Pioneer* in the Chukchi Sea

Source Type	Frequency	Radial Distance (m) to Sound Energy Isopleths							
		120 dB	130 dB	140 dB	150 dB	160 dB	170 dB	180 dB	190 dB
Side-scan sonar [1]	410 kHz	130	74	36	15	5	<2	--	--
Multi-beam sonar [2]	300 kHz	72	31	11	4	1	--	--	--
Multi-beam sonar [3]	200 kHz	270	130	51	15	4	--	--	--
Sub-bottom profiler [4]	3-7 kHz	240	75	24	8	3	--	--	--
Sub-bottom profiler [5]	3-12 kHz	240	96	39	16	6	--	--	--

[1] EdgeTech dual frequency on an Autonomous Underwater Vehicle towed behind the *Ocean Pioneer* in the Burger Prospect, Chukchi Sea, Best Fit from Chorney et al (2011); also reported rms SPL source levels of 164.1-174.6
[2] Kongsberg EM 3002 vessel mounted on the *Ocean Pioneer* in the Burger Prospect, Chukchi Sea, Best Fit from Chorney et al (2011); rms SPL source level reported of 161.6 dB
[3] Kongsberg EM 2000 on an Autonomous Underwater Vehicle towed behind the *Ocean Pioneer* in the Burger Prospect, Chukchi Sea, Best Fit from Chorney et al (2011); rms SPL source levels reported of 177.9-182.5 dB
[4] Values are upper range for EdgeTech 216 on an Autonomous Underwater Vehicle towed behind the *Ocean Pioneer* in the Burger Prospect, Chukchi Sea, Best Fit from Chorney et al (2011); rms SPL source levels reported of 163.1-167.6 dB
[6] Values are upper range for EdgeTech 3100 on a towfish in the Burger Prospect, Chukchi Sea, Best Fit from Chorney et al (2011)

Table 4.1.6-3 Geophysical Equipment Sound on the *Mt Mitchell* in the Beaufort & Chukchi Seas

Source Type	Frequency	Radial Distance to Sound Energy Isopleths							
		120 dB	130 dB	140 dB	150 dB	160 dB	170 dB	180 dB	190 dB
Sub-bottom profiler [1]	3.5 kHz	580	230	90	35	14	--	--	--
Sub-bottom profiler [2]	3.5 kHz	660	220	75	25	8	--	--	--
Sub-bottom profiler [3]	3.5 kHz	1,600	530	170	52	16	5	1	--
Multi-beam sonar [4]	240 kHz	260	160	87	43	20	9	4	2
Side-scan sonar [5]	120 kHz	1,100	790	470	220	67	14	3	--
Side-scan sonar [6]	400 kHz	290	210	130	71	30	10	3	--
Single-beam sonar [7]	205 kHz	ND	ND	ND	ND	ND	ND	ND	ND

[1] Geopulse 3.5 kHz sub-bottom profiler mounted on a swinging pole off the *Mt Mitchell* in the Honeyguide Prospect, Chukchi Sea, Best Fit from Warner et al 2010
[2] Geopulse 3.5 kHz sub-bottom profiler mounted on a swinging pole off the *Mt Mitchell* in the Burger Prospect, Chukchi Sea, Best Fit from Warner et al 2010
[3] Geopulse 3.5 kHz sub-bottom profiler mounted on a swinging pole off the *Mt Mitchell* in the Beaufort Sea, Best Fit from Chorney et al 2011
[4] RESON Seabat 8101 240 kHz sub-bottom profiler mounted on a pole midship on the *Mt Mitchell* in the Beaufort Sea, Best Fit from Chorney et al 2011; rms SPL source level of 199.9 dB reported
[5] EdgeTech 4200-MP Dual Frequency 120-kHz side-scan sonar on a towfish towed by the *Mt Mitchell* in the Beaufort Sea, Best Fit from Chorney et al 2011; rms SPL source level of 198.1 dB reported
[6] EdgeTech 4200-MP Dual Frequency 400-kHz side-scan sonar on a towfish towed by the *Mt Mitchell* in the Beaufort Sea, Best Fit from Chorney et al 2011; rms SPL source level of 195.5 dB reported
[7] Odum Echotrac CVM 250 kHz single beam sonar vessel-mounted on the *Mt Mitchell* in the Beaufort Sea; source level of 150.5 dB reported rms SPL (Chorney et al 2011)
ND equals No Data provided in report

Impact of Geophysical and Geotechnical Equipment Sound Energy on Lower Trophic Organisms

Bodies of marine invertebrates are generally the same density as the surrounding water so that sudden changes in pressure, such as that caused by sudden loud sound, are unlikely to cause physical damage. Phytoplankton species are characterized by having relatively resistant unicellular structures (Harris 1986). 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 (Hartline et al. 1996; Wong 1996) respectively, and therefore have some sensitivity to sound.

The effect of sound energy generated by geotechnical coring or the operation of bathymetric sonars, sub-bottom profilers, and side-scan sonars, on benthic or planktonic organisms has not been studied, but the effect of other types of underwater sound has been investigated. Some work has been done evaluating potential effects on marine invertebrates (e.g., crabs and bivalves) and other marine organisms (e.g., sea sponges and polychaetes) from seismic airguns but these generate much greater sound intensity than the equipment proposed for the marine survey program. 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 at 3.3 ft (1.0 m) in water depths of 6.6 ft (2.0 m). Koshleva (1992) reported no detectable effects on mussels (*Mytilus edulis*), periwinkles (*Littorina* spp.) and an amphipod (*Gammarus locusta*) at distances as close as 0.5 m from an airgun with a source level of 223 dB. According to reviews by Thomson and Davis (2001) and Moriyasu et al. (2004), seismic survey sound pulses have limited effect on benthic invertebrates, and observed effects are typically restricted to animals within a few meters of the sound source. 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 sub lethal effects (e.g., reduced growth, behavioral changes) were noted (CDFO 2004). However, no appreciable adverse impact on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. This is consistent with BOEM's (MMS 2007b) conclusions that the effect of seismic exploration on benthic organisms probably would be very low and not measurable (MMS 2007b).

Sound energy generated by geophysical and geotechnical surveys will be at much lower levels than that generated from seismic equipment and reviewed above, and will likely have no effect on zooplankton, phytoplankton. Additionally, plankton populations are characterized by short generation times of approximately one year (MMS 2006a) and high natural mortality rates, up to 99 percent annually in some species (McCauley 1994), so that any population effects would be obscured or recover rapidly. Therefore, any effects of geophysical and geotechnical equipment sound energy on localized populations would be negligible or nonexistent.

Analysis of Impact of Sound Energy Geophysical and Geotechnical Equipment on Marine Fish

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

Fish hearing capabilities have been reviewed by a number of authors including Popper 2008, Fay 1988, and Nedwell et al. 2004, and hearing thresholds have been determined for about 100 different species of fish (Popper 2008). With regards to hearing, fish species are often categorized as hearing generalists and hearing specialists or otophisines. The optimum range for most species is between infrasound <20 Hz (Sand and Karlsen 1986) and 700 Hz (Platt and Popper 1981, Buerkle 1968, Chapman and Hawkins 1973, Offut 1974). A few species have good hearing up to 2,000 Hz (Hawkins 1981). With very few exceptions, fish cannot hear sounds above 3-4 kHz (Popper 2008). Hearing generalists generally detect sounds with

frequencies up to about 1.5 kH (Popper 2008). Fish such as mackerel, flatfish and some other bottom-living species, which do not have a swim bladder, have poorer hearing than species such as cod and herring, which have a well-developed swim bladder (Hawkins 1981). Some hearing specialists such as the clupeids (herrings, sardines, anchovies) can detect sounds with frequencies up to 4-5 kHz. The frequencies at which the geophysical equipment planned for the surveys would operate is above and outside of the hearing range of fish and would therefore have no or negligible effect on fish. Any sound energy generated by the equipment would likely be overshadowed by the sound generated by operation of the vessel and therefore have no incremental effect.

Impact of Sound Energy Generated by Geophysical and Geotechnical Equipment on Birds

The sound energy to be generated by Shell's marine survey program is likely to have no effect on birds. These are primarily underwater sounds, while birds spend most of their time on or above the water. Additionally, the sound energy generated by the geophysical equipment is generated a relatively low level and attenuates rapidly. Temporary displacement of the birds by the presence of the vessel is likely to keep the bird at a distance from the sound source such that received sound levels are very low.

Studies on the effects of seismic surveys on birds provide some indication of how sound energy generated by geophysical and geotechnical surveys could affect birds. Seismic surveys produce underwater sound (source levels of approximately 220-250 dB), which is much stronger than what is produced from the types of surveys planned by Shell for the 2013 Chukchi Sea open water marine survey program (Table 4.1.6-1, 4.1.6-2, and 4.1.6-3). Evans et al. (1993) evaluated potential effects on marine birds from operating seismic vessels in the North Sea and found no observable difference in bird behavior. Birds did not show differences in behavior when close or far from the survey vessels and the birds were neither repelled nor attracted to the vessels. Similarly, studies in the Canadian Arctic (Webb and Kempf 1998) and Wadden Sea (Stemp 1985) found no statistical differences in bird distribution between with and without on-going seismic surveys. Lacroix et al. (2003) investigated the effects of a marine seismic survey on molting long-tailed ducks in the Beaufort Sea and found that the survey program had no effect on the movements, diving behavior or site fidelity of the ducks.

These studies indicate that vessels the size of Shell's survey vessel and larger, in combination with sound sources (seismic airguns) that generate sound levels in excess of that expected for the planned open water marine surveys, result in no short term or long term effects on birds. Any effects that might occur from Shell's marine survey program would be less in magnitude and consist of temporary and minor behavior responses such as the flushing of birds from the vicinity of the vessel. Any such effects would likely last only minutes to a few hours at the most and be biologically insignificant at population levels.

Impact of Sound Energy on Threatened and Endangered Birds and Critical Habitat

Any effects on Steller's and spectacled eiders (threatened), Kittlitz's murrelets (candidate), and yellow billed loons (candidate) from sound energy generated by the operation of geophysical or geotechnical equipment during the marine surveys will be short term and negligible, and the same as those on other marine and coastal bird species as described above. Spectacled eiders critical habitat in Ledyard Bay would not be affected because the sound energy attenuates rapidly and would likely not be perceptible in the LBCHU.

Marine surveys will commence in mid-July, after the spring migration of these species is completed. In mid-July to mid-October, these birds are found in relatively low densities in offshore waters. Densities of Steller's eiders are very low in the survey area; densities of spectacled eiders are generally low in the survey area during summer, increasing in the fall. Yellow-billed loons are also found in low densities offshore, being more prevalent in nearshore portions of the survey area. Kittlitz's murrelets are found in low densities in the offshore portions of the survey area. Thus relatively few if any of the birds would be expected to occur within the ensonified area. Birds exposed to sound energy from the geophysical or geotechnical activities would either move from the area or show little reaction. Geophysical surveys will not be conducted in areas known to sometimes hold concentrations of the birds, such as Ledyard Bay, Kasegaluk Lagoon, or Peard Bay. Sound energy levels expected to be generated by the equipment are generally lower than those produced by the vessel itself and to attenuate more rapidly, therefore no additional disturbance impacts are expected for the geophysical and geotechnical equipment beyond what would occur from the presence of the vessel and operation of the vessel engines.

Impact of Geophysical and Geotechnical Equipment Sound Energy on Marine Mammals

Detailed reviews of the effects of sound, including sound generated by geophysical surveys, have been prepared by Richardson et al. (1995a), Southall et al. (2007) and others. The primary effects of concern include disturbance reactions and consequent changes in distribution or habitat use, masking of marine mammal communications, and hearing impairment – either temporary threshold shift (TSS) or permanent threshold shift (PTS). Shell has prepared and provided BOEM with detailed assessments of the potential effects of sound energy for its exploration drilling program in conjunction with the Revised Chukchi Sea EP (Shell 2011a) and specifically for the planned 2013 Chukchi Sea open water marine survey program in its application for an IHA (Shell 2013). The findings in these reviews are summarized below. The reader is referred to the referenced documents for a more thorough analysis.

Sound Energy from the Operation of Geophysical and Geotechnical Equipment

Acoustical equipment could potentially affect marine mammals behaviorally or physiologically. To have a behavioral effect it is thought that the sounds must be perceived by the animal. In Table 4.1.6-4, marine mammal hearing ranges are compared to the frequencies at which geophysical equipment has been operated for surveys in the Chukchi Sea in the past and may be used for the 2013 Chukchi Sea Open Water Survey Program in 2013.

Table 4.1.6-4 Geophysical Equipment Frequencies and Marine Mammal Hearing Ranges

Geophysical Equipment			Marine Mammal Hearing Range			
Equipment	Frequency	Source Level [12]	Low Frequency Cetaceans [13]	Mid Frequency Cetaceans [14]	High Frequency Cetaceans [15]	Pinnipeds in Water [16]
Single beam sonar [1]	18 kHz [5]	218.0 dB	7 Hz – 22 kHz	150–160 kHz	200 Hz – 180 kHz	75 Hz – 75 kHz
Single beam sonar [2]	18 kHz [6]	161.8 dB				
Single beam sonar [2]	200 kHz [7]	158.0 dB				
Single beam sonar [3]	200 kHz	150.5 dB				
Multi-beam [4]	300 kHz	161.6 dB	7 Hz – 22 kHz	150–160 kHz	200 Hz – 180 kHz	75 Hz – 75 kHz
Multi-beam [5]	200 kHz	182.5 dB				
Multi-beam [6]	240 kHz	199.9 dB				
Side-scan sonar [7]	410 kHz	174.5 dB	7 Hz – 22 kHz	150–160 kHz	200 Hz – 180 kHz	75 Hz – 75 kHz
Side-scan sonar [8]	120 kHz	198.1 dB				
Side-scan sonar9	400 kHz	195.5 dB				
Sub-bottom profiler	3-7 kHz	--	7 Hz – 22 kHz	150–160 kHz	200 Hz – 180 kHz	75 Hz – 75 kHz
Sub-bottom profiler [10]	3-7 kHz	167.6 dB				
Sub-bottom profiler [11]	2-7 kHz	195.9 dB				

[1] Simrad EA502 single beam sonar in Chukchi Sea for Statoil site clearance surveys in beam source level (Warner and McCrodan 2011)
[2] Kongsberg EA600 single beam sonar in Chukchi Sea for Statoil geotechnical surveys (Warner and McCrodan 2011)
[3] Odum Echotrac CVM 200 kHz single beam sonar vessel-mounted on the Mt Mitchell in the Beaufort Sea; specifications were 200 kHz but measured frequency was 205 kHz; rms SP L source level of 150.5 dB (Chorney et al 2011)
[4] Kongsberg EM 3002 pole mounted multi-beam sonar in the Chukchi Sea source level 161.6 dB rms SPL (Chorney et al. 2011)
[5] Kongsberg EM 2000 multi-beam sonar on AUV in the Chukchi Sea upper limit source level 182.5 dB rms SPL (Chorney et al. 2011)
[6] Reson SeaBat 8101 multi-beam sonar pole mounted on Mt Mitchell in Beaufort Sea (Chorney et al. 2011)
[7] EdgeTech dual frequency side-scan sonar on AUV behind Ocean Pioneer in Chukchi Sea source level 164.1-174.5 dB rms SPL (Chorney et al. 2011)
[8] EdgeTech 4200-MP dual frequency side-scan sonar on towfish behind Mt Mitchell in Beaufort Sea (Chorney et al. 2011) in beam source level
[9] EdgeTech 4200-MP dual frequency side-scan sonar on towfish behind Mt Mitchell in Beaufort Sea (Chorney et al. 2011) in beam source level
[10] EdgeTech 217 sub-bottom profiler on AUV behind Ocean Pioneer in Chukchi Sea (Chorney et al. 2011) source level 163.1-167.6 dB rms SPL (Chorney et al. 2011)
[11] Kongsberg SBP300 sub-bottom profiler on the vessel Duke in the Chukchi Sea (Warner and McCrodan 2011)
[12] Estimated (back-propagated) source level in root mean squares (rms)
[13] From Southall et al. 2007, low frequency cetaceans include bowhead whales, gray whales, humpback whales, fin whales (Southall 2007)
[14] From Southall et al. 2007, mid frequency cetaceans include beluga whales, killer whales (Southall 2007)
[15] From Southall et al. 2007, high frequency cetaceans include harbor porpoises (Southall 2007)
[16] From Southall et al. 2007, pinnipeds include spotted seals, ringed seals, and bearded seals (Southall 2007)

These data indicate that all multi-beam sonars, all side-scan sonars, and most single beam sonars used in the Chukchi Sea are operated at frequencies that are above what is thought to be the hearing range of most marine mammal species. Sound energy from these types of equipment when operated for the planned open water marine surveys would therefore be expected to have no effect on marine mammals.

Sub-bottom profilers and some single beam sonars are operated at relatively low frequencies (3-7 kHz and 18-24 kHz respectively), and could be perceived by marine mammals such as gray whales, minke whales, beluga, killer whales, harbor porpoises, and spotted seals. Single beam sonars and sub-bottom profilers are operated only when the vessel is operating and moving under power. The sound energy generated by the operation of the geophysical equipment sonar attenuates rather rapidly and received sound energy levels such as 180 dB, 160 dB, and 120dB from a single beam sonar or a sub-bottom profiler are generally experienced at the same distance or shorter distances from a vessel as the sound energy from vessel itself (Table 4.1.6-5) so that there is no additional area of effect due to the operation of a multi-beam or single beam sonar.

Table 4.1.6-5 Reported Single Beam Sonar and Sub-bottom Profiler Sound Level Radii

Source Type	Radial Distance to Sound Energy Isopleths															
	120 dB		130 dB		140 dB		150 dB		160 dB		170 dB		180 dB		190 dB	
	m	yd	m	yd	m	yd	m	yd	m	yd	m	yd	m	yd	m	yd
Single beam sonar [1]	240	262	130	142	74	81	41	45	23	13	13	14	7	8	4	4
Single beam sonar [2]	1,500	1,640	700	766	330	361	150	164	72	79	--	--	--	--	--	--
Sub-bottom profiler [3]	240	262	75	82	24	26	8	9	3	3	--	--	--	--	--	--
Sub-bottom profiler [4]	260	284	70	77	18	20	4	4	1	1	--	--	--	--	--	--
Sub-bottom profiler [5]	580	634	230	252	90	98	35	38	14	15	--	--	--	--	--	--
Sub-bottom profiler [6]	660	722	200	241	62	82	24	27	21	23	19	21	17	19	16	17
Sub-bottom profiler [7]	1,200	1,312	380	416	110	120	28	31	--		--		--		--	
Sub-bottom profiler [8]	1,400	1,531	590	645	240	262	96	105	39	43	16	18	6	7	--	--
Sub-bottom profiler [9]	1,600	1,750	530	186	170	186	52	57	16	17	5	6	1	1	--	--
M/V Ocean Pioneer [10]	800	875	190	208	39	43	8	9	2	2	--	--	--	--	--	--
M/V Ocean Pioneer [11]	1,100	1,203	230	252	48	52	10	11	2	2	--	--	--	--	--	--
M/V Ocean Pioneer [12]	1,200	1,313	240	262	47	51	9	10	2	2	--	--	--	--	--	--
M/V Fugro Synergy [13]	1,200	1,313	190	208	28	31	4	4	1	1	--	--	--	--	--	--
M/V Fugro Synergy [14]	1,500	1,640	270	295	46	50	8	9	1	1	--	--	--	--	--	--
M/V Nordica [15]	2,800	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[1] Kongsberg EA600 single beam sonar in Chukchi Sea at 18 kHz best-fit line radius SPL (Warner and McCrodan 2011)
[2] Simrad EA502 single beam sonar in Chukchi Sea at 18 kHz, best-fit line radius SPL (Warner and McCrodan 2011)
[3] EdgeTech 216 sub-bottom profiler on AUV at 3-7 kHz in Chukchi Sea best fit slant range (Chorney et al. 2011)
[4] EdgeTech 3100 SB-216S sub-bottom profiler at 3-12 kHz on towfish in Beaufort Sea best fit slant range (Chorney et al. 2011)
[5] GeoPulse 3.5 kHz sub-bottom profiler mounted on swing pole on Mt Mitchell in Burger Prospect, Chukchi Sea (Warner et al. 2010)
[6] EdgeTech 3100 SB-216S sub-bottom profiler at 3-12 kHz on towfish in Harrison Bay best fit slant range (Chorney et al. 2011)
[7] Kongsberg SBP300 sub-bottom profiler in Chukchi Sea at 2-7 kHz, best-fit line radius SPL (Warner and McCrodan 2011)
[8] EdgeTech 3100 SB-216S sub-bottom profiler at 3-12 kHz on towfish in Chukchi Sea best fit slant range (Chorney et al. 2011)
[9] GeoPulse sub-bottom profiler at 3.5 kHz on vessel in Harrison Bay best fit slant range (Chorney et al. 2011)
[10] Best Fit estimates from Chorney et al. (2011) forward of the *Ocean Pioneer* transiting at 3.2 knots in the Beaufort Sea
[11] Best Fit estimates from Chorney et al. (2011) forward of the *Ocean Pioneer* transiting at 10 knots in the Chukchi Sea
[12] Best Fit estimates from Chorney et al. (2011) aft of the *Ocean Pioneer* transiting at 10 knots in the Burger Prospect, Chukchi Sea
[13] Best Fit estimates from Warner and McCrodan (2011) forward of the *Fugro Synergy* transiting at 4.5 knots in the Chukchi Sea
[14] Best Fit estimates from Warner and McCrodan (2011) for the *Fugro Synergy* in DP mode while coring in Chukchi Sea
[15] Best Fit estimates from O'Neill and McCrodan (2012)

Geotechnical borings will be conducted at 28 sites in Federal waters, using either a seabed drilling system, or a piston coring / CPT technology. A single-beam, bathymetric sonar (24-500 kHz) will likely be used to assist with navigation, verify water depths at the sites of the geotechnical work, and collect general bathymetry information. Both of these operations generate sound energy that could potentially affect marine mammals.

Single beam sonars generate impulsive sound energy and are typically operated at 18-24 kHz or 200 kHz. Sound at frequencies greater than about 180 kHz are above the hearing range of marine mammals and would be expected to have no effect on marine mammals. Sound energy generated at frequencies of 18-24 kHz would likely be perceived by marine mammals such as the spotted seal, gray whale, minke whale, beluga, and harbor porpoise. However, received sound energy levels at distance are expected to be less than those generated by operation of the ship, and would therefore not result in any additional area of impact. Any impacts from the sound energy generated by the single beam sonar would be negligible consisting of brief behavioral disturbance.

Potential for Masking Effects from Geophysical and Geotechnical Equipment

Masking is primarily a concern with cetaceans, which are known to communicate with con-specifics and use acoustic clues for prey location and predator avoidance. It is unlikely that cetacean communications would be masked appreciably by operation of the single beam sonar or sub-bottom profiler during the survey program given the low duty cycle of the sonar, directionality of the beam, and the brief period when an individual animal is likely to be within the sonar beam where it could be exposed. Additionally, the frequencies at which the sub-bottom profiler proposed for the 2013 marine surveys would be operated at would not overlap with the predominant frequencies in baleen whale calls, further reducing any potential for masking in gray whales or minke whales. Odontocetes have better hearing capabilities at higher frequencies than these baleen whales and a much wider range, with the hearing range extending to 180 kHz for some species. Some odontocetes are also capable of hearing low frequencies (e.g., <500 Hz) but their sensitivity at these low frequencies seems poor (Richardson et al. 1995a). Beluga whales are the only odontocetes likely to occur in the proposed survey area, although small numbers of harbor porpoise could also occur in the survey areas. Single beam sonar and sub-bottom sonars would be operated at the low end of their hearing range where sensitivity is low. However, the sub-bottom profiling equipment operates at low energy levels and sound propagation is limited and unlikely to be audible to most beluga whales. Any masking effects on cetacean communication from operation of the geophysical equipment would be negligible and brief.

Effects on Hearing Impairment from Geophysical and Geotechnical Equipment

Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds ≥180 and 190 dB re 1 μPa (rms), respectively (NMFS 2000). These exposure levels have also been applied by the USFWS to walrus and polar bear, respectively. However, these criteria were established before there were any data on the minimum received levels of sounds necessary to cause temporary auditory impairment in marine mammals summarized here:

- the 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid TTS, let alone permanent auditory injury, at least for belugas and delphinids.
- the minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable Temporary Threshold Shift (TTS).
- the level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

Received sound energy levels generated by operation of the geophysical and geotechnical equipment planned for the 2013 Chukchi Sea open water marine survey program are expected to not exceed these precautionary levels at the source, or the sound will rapidly attenuate to lower levels within a few meters of the source. Operation of the vessel is expected to generate sound energy at levels that exceed that generated by the sonar or sub-bottom profilers, and displace marine mammals from the immediate vicinity of the vessel. Additionally, at any given location, an individual cetacean or pinniped would be in the beam of the sonar for a very brief time given the generally downward orientation of the beam and its narrow fore-aft beam width. Given these

factors, the small scale of the survey, and the relatively low density at which marine mammals are found at, operation of the geophysical and geotechnical equipment would be expected to have no effect on marine mammal hearing.

Disturbance Reactions from Geophysical and Geotechnical Equipment

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound. This practice likely overestimates the numbers of marine mammals that are affected in some biologically-important manner.

Pulsed Sounds – Geophysical Equipment

Behavioral reactions of free-ranging marine mammals to military and other sonars appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins et al. 1985), increased vocalizations and no dispersal by pilot whales (Rendell and Gordon 1999). Also, Navy personnel have described observations of dolphins bow-riding adjacent to bow-mounted mid-frequency sonars during sonar transmissions. During exposure to a 21–25 kHz whale-finding sonar with a source level of 215 dB re 1 μPa • m, gray whales showed slight avoidance (~200 m or 656 ft) behavior (Frankel 2005). Pulse durations from the Navy sonars are much longer than those of the bathymetric sonars to be used during the marine survey program. A given mammal would receive many pulses from the naval sonars. During Shell's survey program, the individual pulses will be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes.

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 s pulsed sounds at frequencies much lower than those that will be emitted by the bathymetric sonar to be used by Shell, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt et al. 2000; Finneran et al. 2002; Finneran and Schlundt 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in either duration or bandwidth as compared with those from bathymetric sonar.

We are not aware of any data on the reactions of pinnipeds to sonar sounds at frequencies similar to those of the bathymetric sonar equipment. Additionally, pinniped hearing sensitivity is probably low at the relatively high frequencies of the proposed sonars. Based on observed pinniped responses to other types of pulsed sounds, and the likely brevity of exposure to the bathymetric sonar sounds, pinniped reactions to the sonar sounds are expected to be limited to startle or otherwise brief responses of no lasting consequence to the animals.

Marine mammals that may be exposed to the sound energy include gray whales, minke whales, belugas, harbor porpoises, and spotted seals. All are found at relatively low densities across the survey area during the time period when the surveys would take place. Small numbers of these species could potentially be exposed to the sound energy. Some may react and/or avoid the area.

Any such startle or avoidance reactions would be brief and have only short term effect on the animals behavior or distribution. All such effects would be negligible and short term.

Non-pulsed Sounds – Geotechnical Coring

Continuous or non-pulsed sounds such as those associated with geotechnical coring activities can have effects on marine mammals including behavioral disturbance, (Richardson et al. 1995a).

Baleen Whales - Southall et al. (2007) reviewed a number of papers describing the responses of marine mammals to non-pulsed sound. In general, little or no response was observed in animals exposed at received levels from 90-120 dB. Probability of avoidance and other behavioral effects increased when received levels were 120-160 dB. Some of the relevant reviews of Southall et al. (2007) are summarized below.

Frankel & Clark (1998) conducted playback experiments with wintering humpback whales using a single speaker producing a low-frequency "M-sequence" (sine wave with multiple-phase reversals) signal in the 60-90 Hz band with output of 172 dB at 1 m. For 11 playbacks, exposures were between 120 and 130 dB re: 1 μPa and included sufficient information regarding individual responses. During eight of the trials, there were no measurable differences in tracks or bearings relative to control conditions, whereas on three occasions, whales either moved slightly away from (n = 1) or towards (n = 2) the playback speaker during exposure. The presence of the source vessel itself had a greater effect than did the M-sequence playback.

Finally, Nowacek et al. (2004) used controlled exposures to demonstrate behavioral reactions of northern right whales to various nonpulse sounds. Playback stimuli included ship noise, social sounds of conspecifics, and a complex, 18-min "alert" sound consisting of repetitions of three different artificial signals. Ten whales were tagged with calibrated instruments that measured received sound characteristics and concurrent animal movements in three dimensions. Five out of six exposed whales reacted strongly to alert signals at measured received levels between 130 and 150 dB (i.e., ceased foraging and swam rapidly to the surface). Two of these individuals were not exposed to ship noise and the other four were exposed to both stimuli. These whales reacted mildly to conspecific signals. Seven whales, including the four exposed to the alert stimulus, had no measurable response to either ship sounds or actual vessel noise.

Toothed Whales - Most toothed whales have the greatest hearing sensitivity at frequencies much higher than that of baleen whales and may be less responsive to low-frequency sound commonly associated with industry activities.

In reviewing responses of cetaceans with best hearing in mid-frequency ranges, which includes toothed whales, Southall et al. (2007) reported that combined field and laboratory data for mid-frequency cetaceans exposed to nonpulse sounds did not lead to a clear conclusion about received levels coincident with various behavioral responses. In some settings, individuals in the field showed profound behavioral responses to exposures from 90-120 dB, while others failed to exhibit such responses for exposure to received levels from 120-150 dB. Contextual variables other than exposure received level, and probable species differences, are the likely reasons for this variability. Context, including the fact that captive subjects were often directly reinforced with food for tolerating noise exposure, may also explain why there was great disparity in results from field and laboratory conditions—exposures in captive settings generally exceeded 170 dB before inducing behavioral responses. Below we summarize some of the relevant material reviewed by Southall et al. (2007).

Awbrey and Stewart (1983) played back semi-submersible drillship sounds (source level: 163 dB) to belugas in Alaska. They reported avoidance reactions at 984 and 4,921 ft (300 and 1,500 m) and approach by groups at a distance of 11,483 ft (3,500 m) (received levels approximately 110 to 145 dB over these ranges assuming a 15 log R transmission loss). Similarly, Richardson et al. (1990) played back drilling platform sounds (source level: 163 dB) to belugas in Alaska. They conducted aerial observations of eight individuals among approximately 100 spread over an area several hundred meters to several kilometers from the sound source and found no obvious reactions. Moderate changes in movement were noted for three groups swimming within 656 ft (200 m) of the sound projector.

Several researchers conducting laboratory experiments on hearing and the effects of nonpulse sounds on hearing in mid-frequency cetaceans have reported concurrent behavioral responses. Nachtigall et al. (2003) reported that noise exposures up to 179 dB and 55-min duration affected the trained behaviors of a bottlenose dolphin participating in a TTS experiment. Finneran and Schlundt (2004) provided a detailed, comprehensive analysis of the behavioral responses of belugas and bottlenose dolphins to 1-s tones (received levels 160-202 dB) in the context of TTS experiments. Romano et al. (2004) investigated the physiological responses of a bottlenose dolphin and a beluga exposed to these tonal exposures and demonstrated a decrease in blood cortisol levels during a series of exposures between 130 and 201 dB. Collectively, the laboratory observations suggested the onset of behavioral response at higher received levels than did field studies. The differences were likely related to the very different conditions and contextual variables between untrained, free-ranging individuals vs. laboratory subjects that were rewarded with food for tolerating noise exposure.

Pinnipeds - Reactions of pinnipeds to drilling and related activities have not been studied extensively. Pinnipeds generally seem to be less responsive to exposure to industrial sound than most cetaceans. Ringed seals were often seen near drillships in the Arctic during earlier exploration drilling programs (Ward and Pessah 1986, Brueggeman et al. 1991, Gallagher et al. 1992, Brewer et al. 1993, Hall et al. 1994). In spring, some ringed and bearded seals approached and dove within 164 ft (50 m) of an underwater sound projector broadcasting steady low frequency drilling sounds (Richardson et al. 1990, 1991). Received sound levels at the locations of the seals were estimated to be approximately 130 dB re 1uPa.

Southall et al. (2007) reviewed literature describing responses of pinnipeds to non-pulsed sound and reported that the limited data suggest exposures between approximately 90 and 140 dB generally do not appear to induce strong behavioral responses in pinnipeds exposed to nonpulse sounds in water; no data exist regarding exposures at higher levels. It is important to note that among these studies of pinnipeds responding to nonpulse exposures in water, there are some apparent differences in responses between field and laboratory conditions. In contrast to the mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field. Again, contextual issues are the likely cause of this difference.

Conclusions - Marine mammals that may be exposed to non-pulsed sound generated by the geotechnical coring operations include gray whales, minke whales, belugas, harbor porpoises, and spotted seals. All are found at relatively low densities across the survey area during the time period when the surveys would take place. Small numbers of these species could potentially be exposed to the sound energy. Other species that occur in the Chukchi Sea but are unlikely to occur in the vicinity of the survey vessel as they are rare include killer whales, and ribbon seals.

Estimates of the numbers of marine mammals that might be exposed were prepared for the application for an IHA and are provided below in Table 4.1.6-6.

Table 4.1.6-6 Potential Marine Mammal Exposures to Sound from Geotechnical Coring

Species	Number of Exposures to Sound Levels > 120 dB [1]					
	During Summer		During Fall		Total Exposures	
	Avg	Max[1]	Avg	Max[1]	Avg	Max[1]
Beluga	1	3	1	2	2	5
Narwhal	0	0	0	0	0	5
Killer whale	0	0	0	0	0	5
Harbor porpoise	2	3	1	2	3	5
Bowhead whale	1	3	10	19	11	22
Fin whale	0	0	0	0	0	5
Gray whale	26	52	3	6	29	58
Humpback whale	0	0	0	0	0	5
Minke whale	0	0	0	0	0	5
Bearded seal	11	21	4	8	15	29
Ribbon seal	1	3	0	1	1	5
Ringed seal	381	632	102	169	484	801
Spotted seal	8	13	2	3	10	16

[1] Source: Shell's application for an IHA (Shell 2013)

[2] Based on radius to 120 dB rms from the vessel at DP as that radius likely exceeds that of the geotechnical coring

Some of these exposed animals may react and/or avoid the area. No significant or lasting impacts to marine mammals from the sound energy that will be generated by geophysical or geotechnical equipment are expected. The most likely effects of these activities are temporary avoidance of the area by most marine mammals. Avoidance of the area is likely to last as long as operations are ongoing, but is unlikely to persist once activities cease. All such effects would be negligible and short term.

Effects of Geophysical and Geotechnical Sound on Threatened and Endangered Marine Mammals

Any impacts of sound generated by geophysical and geotechnical equipment on bowhead, humpback, and fin whales (endangered), ringed and bearded seals (threatened), and Pacific walrus (candidate) would be similar to those discussed above for baleen whales and pinnipeds respectively. Fin whales and humpback whales and not expected to be in the survey area when Shell would conduct the marine survey program in numbers that make any encounters or exposures likely.

During much of the survey period few bowheads will be present in the survey area as most summer in the Canadian Beaufort Sea. Migrating bowheads could encounter the survey operations as they move west or south across the Chukchi Sea to feeding areas along the Russian coast before moving down the Russian coast into the Bering Sea wintering grounds. In recent years, bowheads have been seen feeding in the Peard Bay area in the Chukchi Sea (Thomas et al. 2010). Bowheads have been shown to be more tolerant of industrial sounds when involved in feeding behavior than when engaged in other activities (Koski et al. 2008, Christie et al. 2010). Previous studies have not found that avoidance of drilling or other industrial operations has impeded the fall migration of bowhead whales (Davis 1987, Gallagher et al. 1992a; Brewer et al. 1993; Funk et al. 2010). Masking of the ability of bowheads, fin whales, humpback whales to hear the calls of others and their ability to make their calls heard is unlikely as described above

for other baleen whales. Based on these numbers and the above analysis, the effects of sound energy generated by geophysical and geotechnical equipment on threatened and endangered whales would be minor and temporary, affecting some bowheads and few if any fin or humpback whales. Any effects would be minor, consisting of temporary behavioral responses.

Effects of Geophysical and Geotechnical Sound on Threatened and Endangered Pinnipeds

Potential impacts of sound generated by geophysical and geotechnical equipment on ringed and bearded seals (threatened) and Pacific walrus (candidate) would be similar to those discussed in detail for other pinnipeds as described above.

Ringed seals have been found to have very limited response to industrial activities and this would be expected to be the case for geotechnical coring. Brewer et al. (1993) observed ringed seals approaching within 33 ft (10 m) of the drilling vessel *Kulluk* in the Beaufort Sea and concluded that seals were not disturbed by drilling activity; the same conclusion was reached for bearded seals that approached within 656 ft (200 m) of ice breakers. While monitoring marine mammals at another historical Beaufort Sea drill site, Gallagher et al. (1992a) observed seals within 115 ft (35 m) of the drillship *Explorer II* indicating a high level of tolerance to such sounds and activities. Studies have shown that ringed seals exhibit little or no reaction to industrial or construction activities, such as pipe-driving, that produce underwater sounds 1.0-6.0 mi (1.6-10.0 km) from the source (Moulton et al. 2003, 2005; Blackwell et al. 2004).

Ringed and bearded seals have also been shown to have tolerance to geophysical surveys. Harris et al. (2001) observed an equal number of seals from a seismic survey vessel whether the airguns were firing or not but the seals tended to be farther from the vessel. They concluded that there was partial avoidance of the area within 492 ft (150 m) of the operating vessel, but added that the seals did not move much beyond 656 ft (200 m) from the vessel. They found no significant differences in relative frequencies of a set of behaviors by the seals with and without airgun operation, indicating little or no effects on seals from the survey. Pinnipeds will tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding or reproduction (Mate and Harvey 1987, Reeves et al. 1996).

Walrus commonly react to moving vessels, but most reports indicate relatively little reaction to sound energy from drilling (Richardson et al. 1995a) indicating geotechnical coring would have little effect. Brueggeman et al. (1990) noted that walrus exhibited some avoidance behavior near moving ice breakers with most walrus reactions occurring when the vessels approached to within 0.3 mi (0.5 km). Ringed seals, bearded seals, and walrus would need to remain in the high-noise field for extended periods of time to sustain any permanent injury. Existing evidence also suggests that while seals may be capable of hearing sounds from airgun arrays, they appear to tolerate intense pulse sounds produced by airgun arrays with little effect if there is no danger associated with the noise.

Masking can interfere with the detection of important natural sound sources. Underwater industrial sounds could possibly mask environmental sounds (Terhune 1981) or communication between marine mammals (Perry and Renouf 1987). However, in a study conducted by Cummings et al. (1984) in which breeding ringed seals were subjected to recordings of industrial sounds, there were no documented effects on ringed seal vocalizations. Impacts of masking, if any, would be restricted to a relatively small area when compared to available seal and walrus habitat in the Chukchi Sea. Consequences of this potential masking are expected to be negligible.

Shell's mitigation measures prohibit the survey vessel from operating within 0.5 mi (800 m) of walrus when observed on land or ice. Vessels underway must reduce speed and avoid multiple course changes when within 300 yd (274 m) of whales in the water to avoid separating members from a group. Vessel speed will also be reduced during inclement weather conditions in order to avoid accidental collisions with marine mammals. The Shell survey vessel will not intentionally approach any marine mammal. Given these mitigation measures ice management should have negligible and short term disturbance effects on ringed seals and bearded seals and walrus.

Impact of Sound Energy Generated by Geophysical and Geotechnical Equipment on Subsistence

The effects of the presence of the survey vessel on subsistence are addressed above under the *Impacts of Vessel Traffic on Subsistence*. The primary potential effect of sound energy generated by geophysical or geotechnical equipment on subsistence would be deflection and displacement of subsistence resources (marine mammals and waterfowl). Coastal portions of the survey area encompass areas where some subsistence activities take place during the same time period as the surveys would be conducted. Wainwright residents hunt for bowheads, belugas, seals, and waterfowl in the summer and fall within the survey area. Most of the 28 planned boreholes are expected to be located offshore of subsistence areas; only a small number of the geotechnical boreholes will be located in areas known to be used for these subsistence activities, and the geotechnical operations are expected to be completed within 24 hrs at each location. Ice gouge surveys would be conducted be conducted in these subsistence areas as well.

The analysis of potential effects of sound energy generated by geophysical or geotechnical equipment on the subsistence resources provided above indicate that there would be no effect on waterfowl. Marine mammal subsistence resources such as the bowhead, beluga, ringed, bearded, and spotted seals, and walrus, could likely perceive the sounds generated by geotechnical coring and by operations of the sub-bottom profilers and single beam sonar, and could potentially disperse or become displaced and therefore less available to harvesters. However, the generated sound energy is at such a source level and attenuates so rapidly that the area of effect is very small and probably affects a smaller area than operation of the vessel itself. Thus there is no incremental increase in the effects on subsistence resources.

Only a small number of the geotechnical boreholes and a portion of the ice gouge surveys would take place within areas used for subsistence. Shell will use its system of Subsistence Advisors, and Com Centers to avoid conducting geotechnical or geophysical operations in areas of active subsistence. Given these measures, the sound generated by the operation of geophysical or geotechnical equipment is likely to have no or negligible effect on subsistence activities by Wainwright residents and others in the Chukchi Sea.

4.2 Cumulative Effects

A number of cumulative impact analyses of proposed oil and gas activities have been prepared in several recent years including National Environmental Policy Act (NEPA) Environmental Impact Statements (EISs) and Environmental Assessments (EAs), and ESA Biological Opinions (BOs):

- EA for incidental take regulations walruses and polar bears in the Chukchi Sea (USFWS 2012)
- Draft EIS on the effects of oil and gas activities in the Arctic Ocean (NMFS 2011)

- EA for ancillary activities Statoil shallow hazards surveys) in the Chukchi Sea (BOEMRE 2011a)
- Supplemental EIS for Lease Sale 193 in the Chukchi Sea (BOEMRE 2011b)
- Draft Programmatic EIS for seismic surveys in the Beaufort and Chukchi Seas (MMS 2007a)
- EIS for Lease Sale 193 and seismic surveys in the Chukchi Sea (MMS 2007b)
- Programmatic EA for seismic surveys in Chukchi and Beaufort Seas (MMS 2006c)

Reasonably Foreseeable Activities & Cumulative Effects Analysis

The reader is referred to the above-referenced larger documents for detailed analyses of past, present, and reasonably foreseeable activities in the Chukchi Sea and their potential effects on the environment. These documents cover periods of time ranging from 1-20 years. Shell's marine survey program will occur over a three month period in 2013, with most identified effects being non-existent within one year or less. The only other oil and gas exploration activities that Shell is aware of that are planned for the 2013 open water season are those associated with its Revised Chukchi Sea EP (Shell 2011a).

The following is a summary of the types of activities that are reasonably foreseeable and applicable to this analysis, and an analysis of the incremental effect of Shell's open water marine survey program, when added to the effects of these other activities.

Air Pollutant Emissions

Emissions in the region come primarily from electrical power generating in the villages of Barrow, Wainwright, Point Lay, and Point Hope, with smaller amounts from the operation of heavy equipment, vessels, and vehicles such a scars, trucks, and all-terrain vehicles. These would be expected to continue at the present levels in 2013. Shell plans to conduct exploration drilling in the Chukchi Sea in 2013; emissions expected from those operations are detailed in Section 7.0 of the Revised Chukchi Sea EP (Shell 2011a) and BOEM's (2011) EA.

Effects on air quality from the exploration drilling program would be local, primarily restricted to the area within 1,640 ft (500 m) of the drillship where all NAAQS and AAAQS will be met. BOEM (2011) categorized the effects of the exploration drilling program on air quality as minor and temproarlly limited. Very low quantities of air pollutants will be emitted by the planned marine surveys (Table 4.1-1). These emissions will occur at various locations across the survey area, but not in proximity to on-going exploration drilling operations. Emissions associated with the marine survey program will therefore have no or negligible incremental effect on regional air quality.

Discharges to Marine Waters

Marine discharges that occur in the northeastern Chukchi Sea include permitted discharges from subsistence vessels, cargo barges, oil and gas support and survey vessels, research vessels, and occasionally cruise ships and military vessels, and accidental releases of refined petroleum products. These would be expected to continue at the present levels in 2013. Shell planned exploration drilling operations in the Chukchi Sea in 2013 would involve ocean discharges consisting of permitted discharges of drilling wastes (cutting and drilling fluids) and permitted discharges of wastewaters from the drillship and support vessels. Discharges expected from those operations are detailed in Section 6.0 of the Revised Chukchi Sea EP (Shell 2011a) and BOEM's (2011) EA.

The effects of vessel discharges from Shell's exploration drilling program are analyzed in Section 4.1.2 of the EIA (Shell 2011a). The effects of vessel discharges would be the similar as those described above for the open water marine surveys, but larger in scope because a drillship and about eight support vessels are involved. The analysis indicates that water quality effects from these discharges would be limited to the immediate vicinity of the drillship or vessel. Over 99 percent of the discharge volume would consist of non-contact cooling water, with the primary effect of increased water temperature; however, modeling indicates that the small temperature difference (2.5 °F / 1.4 °C) in the discharge plume would be reduced by 99 percent within 33 ft (10 m) of the outfall. Drill cuttings and water-based drilling fluids will be discharged at the drill site. The main water quality effect of these discharges would turbidity or an increase in TSS in the water column, with TSS loads being reduced to 40 ppm within 328 ft (100 m) of the outfall (Farmayan 2011, Shell Global Solutions 2009, Shell 2011b). These analyses indicate that water quality effects from the discharges associated will be restricted to the immediate vicinity of the vessel or drill site; the same is true for vessel discharges associated with the planned marine surveys, which are less than 1.0 percent of the volumes discharged by the exploration drilling program. Physical separation of the exploration drilling vessels and the survey vessel will ensure there is no additive effect. The same will hold true for other vessel discharges such as barges and cruise ships. The discharges will take place in different locales within the Chukchi Sea, thus there will be a slight increase in areas where these discharges affect water quality. However, oceanographic conditions will result in these effects being ephemeral, lasting only as long as the discharge is occurring. BOEM (2011) concluded that water quality effects from the exploration drilling program would be minor and short term. The EPA has determined that neither vessel discharges (EPA 2008) or wastewater discharges associated with exploration drilling programs (EPA 2012) will result in unreasonable degradation of ocean waters. Given this any cumulative effects on water quality of the Chukchi Sea will be brief and negligible.

Aircraft Traffic

Aircraft traffic in the Chukchi Sea consists of private planes, air cargo, and commercial passenger service to the Chukchi villages, research survey aircraft, and aircraft conducting supporting oil and gas operations (primarily marine mammal monitoring). Aircraft traffic at the Wainwright airport is quantified in Section 4.2.2 of Shell's EIA (Shell 2011b) for the Revised Chukchi Sea EP (Shell 2011a), which averaged about 300 flights/month in 2000-2008. The planned exploration drilling operations will result in additional aircraft (fixed wing and helicopter) traffic.

Aircraft traffic associated with the marine survey program will consist of very few (i.e., perhaps two within three months) if any helicopter trips between coastal airports and a vessel. Some research flights occur within the Chukchi Sea such as those associated with the BWASP and COMIDA programs. Shell's planned exploration drilling program in 2013 will involve about two helicopter flights per day during the drilling season and additional fixed wing flights for marine mammal monitoring. The effects of these flights are analyzed in Section 4.1 of the EIA for Shell Revised Chukchi Sea EP and found to have no or brief and minor effects on environmental resources. These flights in conjunction with the very few if any flights that might occur for the marine survey program will have negligible cumulative effect on resources given the low total number of flights spread over a large area of the Chukchi Sea.

Vessel Traffic

Vessel traffic in the Chukchi Sea consists of subsistence vessels, cargo barges, oil and gas support and survey vessels, research vessels, and occasionally cruise ships and military vessels. Vessel traffic is low in the Chukchi Sea; it is quantified in Section 4.2.2 of Shell's (2011b) EIA for the Revised Chukchi Sea EP (Shell 2011a). Vessel traffic in the 2013 open water season would not be expected to deviate greatly from recent years. Shell plans to have a drillship and about eight support vessels in the Chukchi Sea in support of its exploration drilling program.

Shell's planned marine surveys will involve a single survey vessel over a three month period. The geophysical surveys will be conducted over about 621 mi (1,000 km) of track lines; the geotechnical investigations and transit will result in some additional vessel travel. Approximately 2,000-14,000 vessel miles occurred in the Chukchi Sea per year in 2006-2010 (EIA Section 4.2.2, Shell 2011b). Shell's exploration drilling program, with a drillship and about eight support vessels will also take place in the Chukchi Sea in 2013. Potential effects of vessel traffic associated with Shell's exploration drilling program and those associated with the marine survey program have been found to be negligible or minor on environmental resources. Given the variability of vessel traffic in past years, the total vessel miles in 2013 is likely to be within the historic range, with no incremental increase. Any cumulative effects of the marine survey vessel traffic in conjunction with these other vessel activities would be negligible and brief occurring only as long as the vessels are operating.

Seafloor Disturbance

There are few sources of seafloor disturbance in the northeastern Chukchi. There are no offshore or coastal facilities or development. The villages have earthen boat ramps. The seafloor would be disturbed by exploration drilling, including the mooring of the drillship, the construction of mudline cellars (MLCs) and the discharge of drill cuttings and drilling fluids. Potential seafloor disturbances due to the exploration drilling program are quantified and the environmental impacts are analyzed in Section 4.1.3 of the EIA (shell 2011b) for Shell's Revised Chukchi Sea EP (Shell 2011a).

Shell's exploration drilling program will directly disturb about 3.1 ac (12,619 m^2) of seafloor in the Chukchi Sea and within the survey area. An additional 9.6 ac (0.04 km^2) would be indirectly disturbed by the re-deposition of drill cuttings and drilling fluids. This represents an extremely small portion of the Chukchi Sea seafloor. The marine survey program will result in seafloor disturbance of at most about 0.1 ac (618.9 m^2). Although additive with respect to the Chukchi Sea, the cumulative effects would be negligible given the size of the Chukchi Sea, the small total area affected, and the nature of the impacts.

Anthropogenic Sounds in the Chukchi Sea

MMS (2007b, 2006c) provided a review of the Chukchi Sea soundscape and sound sources. The soundscape of the Chukchi Sea consists of the aggregate of natural sounds created by organisms, wind, waves, and ice, and anthropogenic sounds from aircraft, vessels, and industrial activity. The types and levels of aircraft and vessel traffic that occur in the Chukchi Sea are described above. Sound energy that could potentially be generated in 2013 by drilling, vessel and aircraft traffic, ice management, and vertical seismic profiles associated with Shell's planned exploration drilling program are described in detail in the EIA (Shell 2011b). Other sound sources are expected to continue in 2013 roughly at the same levels as in recent years, although

MMS (2006c) notes that ambient sound levels in the Chukchi Sea, as elsewhere in the Arctic, are variable.

Aircraft result in very momentary and relatively small increases in underwater sound (Tables 4.1.3-1 and 4.1.3-2). The amount of aircraft traffic occurring in the Chukchi Sea is very low and expected to continuie at this rate in 2013. Levels of aircraft traffic associated with the exploration drilling program, as described above are very low. The very few if any helicopter trips that might occur as a result of the marine survey would represent a negligible increase.

Vessel traffic is also low in the Chukchi Sea (see above) and vessel traffic associated with the marine survey program would likely result in no increase in average annual vessel traffic in the area. As indicated above in Tables 4.1.2-1 and 4.1.2-2, sound levels generated by survey vessels are generally low, attenuating to levels below 120 dB in 1,000-3,000 m.

The geophysical and geotechnical equipment planned for the marine surveys will also generate sound, most of which would be expected to attenuate to similar levels with a distance of about 200-1,400 m (Table 4.1.5-5). Sounds expected to be generated by drilling, ice management, and vertical seismic profiles are described in Section 2.9 of the EIA (Shell 2011b) for Shell's Revised Chukchi Sea EP (Shell 2011a). These sounds are predicted to attenuate to 120 dB or less within distances of about 0.81 mi (1.31 km), 4.7 mi (7.63 km), and 6.5 mi (10.5 km) respectively. Additional distance from these sound sources would be required to attenuate to ambient levels; however, the separation of exploration drilling activities and the planned marine surveys are sufficient to prevent additive ensonification in any given area.

5.0 REFERENCES

Aars, J., N.J. Lunn, and A.E. Derocher (eds). 2006. Polar bears: proceedings of the 14th working meeting of the IUCN/SSC Polar Bear Specialist Group. 20–24 June 2005, Seattle, Washington, USA. IUCN, Gland, Switzerland and Cambridge, UK.

ABWC. PowerPoint presentation by the Alaska Beluga Whale Committee at the 2011 Open Water Meeting, Anchorage, AK. Prepared by Chairman Willie Goodwin and Robert Suydam, North Slope Borough.

ACI and SRBA. 1984. Subsistence study of Alaska Eskimo bowhead whaling villages. Report prepared by Alaska Consultants, Inc. and Stephen Braund & Associates for the U.S. Minerals Management Service, Alaska OCS Region, Anchorage.

ACI, C.S. Courtnage, and SRBA. 1984. Barrow arch socioeconomic and sociocultural description. Technical Report 101. NTIS Access No. A99/PB 85-150019. Prepared by Alaska Consultants, Inc., C.S. Courtnage, and Stephen Braund & Associates for the Minerals Management Service, Alaska OCS Region, Anchorage 641 pp.

ADF&G. 1995. An investigation of the sociocultural consequences of Outer Continental Shelf Development in Alaska. OCS study 95-0015 prepared by Alaska Department of Fish and Game, Division of Subsistence, for Minerals Management Service, Alaska OCS Region, Anchorage.

ADF&G. 1996. Community profile database update to Volume 5, Arctic Region. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

AECOM, Inc. 2010a. Wainwright near-term ambient air quality monitoring program annual data report November 2008 through November 2009 final. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc. Anchorage, Alaska.

AECOM, Inc. 2010b. Wainwright permanent ambient air quality monitoring program first quarter data report January through March 2010 final. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

AECOM, Inc. 2010c. Wainwright permanent ambient air quality monitoring program second quarter data report April through June 2010 draft. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

AECOM, Inc. 2010d. Wainwright permanent ambient air quality monitoring program third quarter data report July through September 2010 draft. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

AECOM, Inc. 2011a. Wainwright permanent ambient air quality monitoring program fourth quarter data report October through December 2010 draft. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

AECOM, Inc. 2011b. Wainwright permanent ambient air quality monitoring program annual data report January 2010 through December 2010 final. Unpublished report prepared by AECOM, Inc. for ConocoPhillips Alaska, Inc. Anchorage, Alaska.

Agness, A.M. 2006. Effects and impacts of vessel activity on the Kittlitz's murrelets (Brachyramphus brevirostris) in Glacier Bay, Alaska. Thesis. University of Washington.

Air Sciences, Inc. 2012. OCS Survey EI Chukchi 20122129.xls

Alaska Shorebird Working Group. 2008. Alaska shorebird conservation plan. Version II. Alaska Shorebird Group, Anchorage, Alaska. Accessed March 27, 2009 at http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.

Allen, B. M., and R. P. Angliss. 2012. Alaska marine mammal stock assessments, 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-234, 288 p.

Alliston, W. 1981. The distribution of ringed seals in relation to winter ice-breaking activities in Lake Melville, Labrador. Report prepared by LGL Ltd., St. Johns, Newfoundland for the Arctic Pilot Project, Dome Petroleum Ltd., Calgary, Alberta, CA. 52 pp.

Alverson, D.L. and N.J. Wilimovsky. 1996. Fishery investigations of the southeastern Chukchi Sea. Vol. 2, Chap. 31, pp 843-860 i*n:* N.J. Wilimovsky and J.N. Wolfe (eds.). Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Comission, U.S. Dep. Commerce, Springfield, VA.

Amstrup, S.C. 1995. Movements, distribution, and population dynamics of polar bears in the Beaufort Sea. PhD Dissertation, University of Alaska, Fairbanks, AK. 299 pp.

Amstrup, S.C., G.M. Durner, I. Stirling, and T.L. McDonald. 2005. Allocating harvest among polar bear stocks in the Beaufort Sea. Arctic. 58:247-259.

Auld, A.H. and J.R. Schubel. 1978. Effects of suspended sediment in fish, eggs, and larvae: a laboratory assessment. Estuarine and Coastal Marine Science 6:153-164.

Awbrey, F.T. and B.S. Stewart. 1983. Behavioral responses of wild beluga whales (*Delphinapterus leucas*) to noise from oil drilling. Journal of the Acoustical Society of America, 74, S54.

Bailey, A. 1948. Birds of arctic Alaska. Colorado Museum Natural History Pop. Ser. No.8, 317 pp.

Baker, C.S., L. Herman, B. Bays, and G. Bauer. 1982. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska. Report from Kewalo Basin Marine Mammal Laboratory, Honolulu, Hawaii for National Marine Fisheries Service, Seattle, WA. 78 pp.

Baker, C.S., L. Herman, B. Bays, and G. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeastern Alaska: 1982 season. Report from Kewalo

Basin Marine Mammal Laboratory, Honolulu, Hawaii for the National Marien Fisheries Service, Seattle, WA. 30 pp.

Barber, W., R. Smith, and R. Meyer. 1997. Demersal fish assemblages of the northeastern Chukchi Sea, Alaska. Fishery Bulletin 95:195-209.

Barber, W., M. Vallarino, and R. Smith. 1994. Fish and fish assemblages of the northeastern Chukchi Sea, Alaska. pp 9-1 to 9-22 *in:* W. Barber, R. Smith and T. Weingartner (eds.) Fisheries Oceanography of the Northeast Chukchi Sea. OCS Study MMS 93-0051, Minerals Management Service, Alaska OCS Region, Anchorage, AK.

Bélanger, L. and J. Bédard. 1989. Responses of staging greater snow geese to human disturbance. Journal of Wildlife Management. 53:713-719.

Bendock, T. 1977. Beaufort Sea estruarine fishery study. pp 670-729 *in* Environmental assessment of the Alaskan Continental Shelf, Final Report of the Principal Investigators, Volume 4 Biological Studies, March 1979. National Ocean and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Boulder, CO.

Bent, A.C. 1987. Life histories of North American waterfowl. Dover Publications, Inc., New York.

Bigelow, N.H. and W.M.R. Powers. 2001. Climate, vegetation, and archaeology 14,000-9000 cal yr B.P. in Central Alaska. Arctic Anthropology 38(2):171-195.

Blackwell, S.B., C.R. Greene, Jr., and W.J. Richardson. 2004. Drilling and operational sounds from an oil production island in the ice-covered Beaufort Sea. Journal of the Acoustical Society of America 116:3199-3219.

Blanchard, A.L., C. Parris, and H. Nichols. 2010. Benthic ecology of the Burger and Klondike survey areas: 2009 environmental studies program in the northeastern Chukchi Sea. Prepared for ConocoPhillips Alaska, Inc. and Shell Exploration & Production Company, by University of Alaska, Fairbanks, AK.

Blees, M.K., K.G. Hartin, and D.S. Ireland. 2010. Marine mammal monitoring. (Chapter 5) *in*: M.K. Blees, M.K., K.G. Hartin, D.S. Ireland, and D. Hannay. (eds.). 2010. Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2010: 90-day report. LGL Rep. P1119. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for by Statoil USA E&P Inc., Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 102 pp, plus appendices.

Boehlert, G.W. and M.M. Yoklavich. 1984. Reproduction, embryonic energetics, and the maternal-fetal relationship in the viviparous genus Sebastes. Biological Bulletin 167:354–370.

BOEM. 2011. Environmental Assessment: Shell Gulf of Mexico, Inc. Shell Revised Chukchi Sea Exploration Plan Burger Prospect: Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915 Chukchi Lease Sale 193. Alaska Outer Continental Shelf OCS EIS/EA BOEM 2011-061 Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage AK. 153 pp.

BOEMRE. 2011a. Chukchi Sea Planning Area Statoil USA E&P Inc. 2011 Ancillary Activities Chukchi Sea, Alaska Environmental Assessment. BOEMRE 2011-036. Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska OCS Region, Anchorage. 62 pp. + App.

BOEMRE. 2011b. Chukchi Sea planning area: Oil and gas lease sale 193 in the Chukchi Sea. Final Supplemental Environmental Impact Statement. OCS EIS/EA BOEMRE 2011-041. USDOI,

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

Born, E.W., F.F. Riget, R. Dietz, and D. Andriashek. 1999. Escape responses of hauled out ringed seals (Phoca hispida) to aircraft disturbance. Polar Biology 21(3):171-178.

Boubée, J.A.T., T.L. Dean, D.W. West, and R.F.G. Barrier. 1997. Avoidance of suspended sediment by the juvenile migratory stage of six New Zealand native fish species. New Zealand Journal of Marine and Freshwater Research 31:61-69.

Braham, H.W., M.A. Fraker, and B.D. Krogman. 1980. Spring migration of the western arctic population of bowhead whales. Marine Fisheries Review 42(9-10):36-46.

Brewer, K., M. Gallagher, P. Regos, P. Isert, and J. Hall. 1993. ARCO Alaska, Inc. Kuvlum #1 exploration prospect site specific monitoring program final report. Report prepared by Coastal & Offshore Pacific Corporation, Walnut Creek, California for ARCO Alaska Inc., Anchorage, Alaska. 80 pp.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. shorebird conservation plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA 50 pp.

Brueggeman, J., D. Volsen, R. Grotefendt, G. Green, J. Burns, and D. Ljungblad. 1991. Shell Western E&P Inc. 1990 walrus monitoring program: the Popcorn, Burger, and Crackerjack Prospects in the Chukchi Sea. Report prepared by Ebasco Environmental, Bellevue, WA for Shell Western E&P Inc. 109 pp plus appendices.

Brueggeman, J., C. Malme, R. Grotefendt, D. Volsen, J. Burns, D. Chapman, D. Ljungblad, and G. Green. 1990. Shell Western E&P Inc. 1989 walrus monitoring program: the Klondike, Burger, and Popcorn Prospects in the Chukchi Sea final report. Report prepared by Ebasco Environmental, Bellevue, WA for Shell Western E&P Inc., Houston, TX 121 pp plus appendices.

Brueggeman, J., R. Grotefendt, M. Smultea, G. Green, R. Rowlett, C. Swanson, D. Volsen, C. Bowlby,
C. Malme, R. Mlawski, and J.J. Burns. 1992. 1991 Marine mammal monitoring program (whales and seals) Crackerjack and Diamond Prospects, Chukchi Sea. Report prepared by Ebasco Environmental, Bellevue, WA for Shell Western E&P Inc. and Chevron USA, Inc. 62 pp plus appendices.

Buerkle, U. 1968. Relation of pure tone thresholds to background noise level in the Atlantic cod (*Gadus morhua*). Journal of the Fisheries Research Board of Canada 25:1155-1160.

Burns, J.J. 1981. Bearded seal Erignatus barbatus Erxleben, 1777. pp 145-170 in: S. H. Ridgway and R. J. Harrison (editors) Handbook of marine mammals. Volume 2: Seals. Academic Press, New York, NY.

Burns, J.J. and K.J. Frost. 1979. The natural history and ecology of the bearded seal (*Erignathus barbatus*). pp 311-392 *in* Environmental Assessment of the Alaskan Continental Shelf Final Reports of Principal Investigators, Volume 19, December 1983 National Ocean and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Juneau, AK.

Burns, J. and S. Harbo. 1972. An aerial census of ringed seals, northern coast of Alaska. Arctic 25(4):279-290.

Bustnes, J.O. and G.H. Systad. 2001. Comparative feeding ecology of Steller's eider and long-tailed duck in winter. Waterbirds 24(3):407-412.

Cairns, J. 1968. Suspended solids standards for the protection of aquatic organisms Purdue University Engineering Bulletin Volume 129:16-27.

Calambokidis, J. E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final report for Contract AB133F-03-RP-00078 U.S. Dept of Commerce Western Administrative Center, Seattle, Washington. (available at http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf)

Carney, K.M., and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22: 68–79.

CBD. 2001. Petition to list Kittlitz's murrelet (*Brachyramphus brevirostris*) as endangered under the Endangered Species Act. Center for Biological Diversity, Tucson, AZ. 9 May, 2001.

CDFO. 2004. Review of scientific information on impacts of seismic sound on fish, invertebrates, marine turtles and marine mammals. Habitat Status Report 2004/002, Canadian Department of Fisheries and Oceans, Canadian Science Advisory Secretariat 15 pp.

Chapman, C.J. and A.D. Hawkins. 1973. A field study of hearing in the cod, *Gadus morhua* L. Journal of Comparative Physiology 85:147-167.

Chorney, N.E., G. Warner, J. MacDonnell, A. McCrodan, T. Deveau, C. McPherson, C. O'Neill, D. Hannay, and B. Rideout. 2011. Underwater Sound Measurements. (Chapter 3) In: Reiser, C.M, D.W. Funk, R. Rodrigues, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish and Wild. Serv., Anchorage, AK. 240 pp, plus appendices.

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

Clarke, J., S. Moore, and D. Ljungblad. 1989. Observations on the gray whale (*Eschrichtius robustus*) utilization and patterns in the northeast Chukchi Sea, July-October 1982-1987. Canadian Journal of Zoology 67:2646-2653.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort Seas, 2011. Annual Report, OCS Study BOEM 2012-009. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, Seattle, WA.

Clarke, J.T., Ferguson, M.C., Christman, C.L., Grassia, S.L., Brower, A.A. and Morse, L.J. 2011. Chukchi Offshore Monitoring in Drilling Area (COMIDA) distribution and relative abundance of marine mammals: aerial surveys. final report, OCS Study BOEMRE 2011-06. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, Seattle, WA

Courtenay, W.R., Jr., B.C. Hartig, and E.R. Loisel. 1980. Evaluation of fish populations adjacent to borrow areas of beach nourishment project at Hallandale (Broward County), Florida. Miscellaneous.

Craig, P.C. 1984. Fish resources. pp. 117-131 in J.C. Truett (ed.) Proceedings of a synthesis meeting: The Barrow Arch environment and possible consequences of planned offshore oil and gas development (Sale 85), Girdwood, AK., Oct.30-Nov. 1, 1983. Anchorage,

AK: US Department of Commerce, NOAA, Outer Continental Shelf Environmental Assessment Program, and USDOI, Minerals Management Service, Anchorage, AK.

Craig, P. 1989. Subsistence fisheries at coastal villages in the Alaskan Arctic 1970-1986. Biological Papers of the University of Alaska 24:131-152.

Craig, P., W. Griffiths, S. Johnson, and D. Schell. 1984. Trophic dynamics in an arctic lagoon. pp 347-380 *in:* P. Barnes, D. Schell, and E. Reimnitz (eds.) The Alaskan Beaufort Sea ecosystems and environments. Academic Press, Inc. New York.

Cummings, W.C., D.V. Holliday, and B.J. Lee. 1984. Potential impacts of man-made noise on ringed seals: vocalizations and reactions. pp 95-230 *in* Outer Continental Shelf Environmental Assessment Program Final Report of the Principal Investigators Volume 37 March 1986, U.S. Department of Commerce, NOAA, and U.S. Department of Interior, Minerals Management Service, Anchorage, AK NTIS PB87-107546.

Dau, C.P. and W.W. Larned. 2006. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 25-27 June 2006. Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Dau, C.P. and W.W. Larned. 2007. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 22-24 June 2007. Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Dau, C.P. and W.W. Larned. 2008. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 24-26 June 2008. Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Davis, R.A. 1987. Integration and summary report. pp 1-52 *in:* Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, Autumn 1986. Report by LGL Ltd., King City, Ontario, and Greeneridge Sciences, Santa Barbara, California, for Shell Western E&P Inc., Anchorage, Alaska.

Davis, R.A. and D.H. Thomson. 1984. Marine Mammals. Chapter 4, pp. 47-49 *in*: J.C. Truett (ed.) Proceedings of a synthesis meeting: The Barrow arch environment and possible consequences of planned offshore oil and gas development (Sale 85), Girdwood, AK, Oct. 30-Nov. 1, 1983. Anchorage, AK: USDOC, NOAA, OCSEAP, and USDOI, MMS.+

Day, R.H., D.A. Nigro, and A.K. Prichard. 2000. At-sea habitat use by the Kittlitz's murrelet *Brachyramphus brevirostris* in nearshore waters of Prince William Sound, Alaska. Marine Ornithology 28:105-114.

Day, R., A. Prichard, and J. Rose. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001-2004: final report. Prepared by ABR, Inc. – Environmental and Research Services for BP Exploration (Alaska) Inc. Fairbanks, Alaska.

Derksen, K., E. Taylor, M. Miller, and M. Weller. 1992. Effects of aircraft on behavior and ecology of molting black brant near Teshekpuk Lake, Alaska. Alaska Fish and Wildlife Research Center, U.S. Fish and Wildlife Service, Anchorage, Alaska. 227 pp.

Divoky, G.J. 1987. The distribution and abundance of birds in the eastern Chukchi Sea in late summer and early fall. Outer Continental Shelf Environmental Assessment Program Research Unit 196. Unpublished final report. Outer Continental Shelf Environmental Assessment Program Fairbanks, AK 91 pp. (NTIS PB88-156922/AS) RU 0196

Dunn, J.R., and A.C. Matarese. 1984. Gadidae: development and relationships. pp. 283-299 *in* H.G. Moser, W.J. Richards (eds) Ontogeny and systematics of fishes. Special Publication No 1, American Society of Ichthyologists and Herpetologists, Allen Press, Lawrence, Kansas.

Dunton, K., J. Grebmeier, D. Maidment, and S. Schonberg. 2003. SBI I final report: benthic community structure and biomass in the western arctic: linkage to biological and physical properties. Final project report to National Science Foundation.

Earnst, S.L. 2004. Status assessment and conservation plan for the yellow-billed Loon (*Gavia adamsii*). Scientific Inves

tigations Report 2004-5258,U.S. Geological Survey. 42 pp.

Earnst, S.L., R.A. Stehn, R.M. Platte, W.W. Larned, and E.J. Mallek. 2005. Population size and trends of yellow-billed loons in northern Alaska. Condor 107:289-304.

Envirocon. 1977. Isserk artificial island, environmental baseline and monitoring study, 1977. Report by Envirocon Ltd., Calgary, AB to Imperial Oil Ltd., Calgary, AB. (unpublished manuscript).

EPA. 1986. Bacteriological ambient water quality criteria for marine and fresh recreational waters. EPA 440/5-84-002. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH.

EPA. 2006. Final ocean discharge criteria evaluation of the arctic NPDES general permit for oil and gas exploration (Permit No. AKG-28-0000). Prepared by: Tetra Tech, Inc. Finalized by: U.S. Environmental Protection Agency, Region 10, Office of Water and Watersheds, Seattle, WA.

EPA. 2008. U.S. Environmental Protection Agency 2008 Final Issuance of National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels Fact Sheet. U.S. Environmental Protection Agency, December 18, 2008. 119 pp.

EPA. 2012. Ocean Discharge Criteria Evaluation for oil and gas exploration facilities on the Outer Continental Shelf in the Chukchi Sea, Alaska (NPDES Permit No.: AKG-28-8100). Prepared by: Tetra Tech, Inc., Anchorage, AK, Revised by: U.S. Environmental Protection Agency, Region 10, Office of Water and Watersheds, Seattle, WA.

Evans, P., E. Lewis, and P. Fisher. 1993. A study of the possible effects of seismic testing upon cetaceans in the Irish Sea. Rep. by Sea Watch Foundation, Oxford, for Marathon Oil UK, Ltd. Aberdeen. 35pp.Farmayan, W. 2011. Update modeling of Alaska exploratory well drilling discharges. Shell Global Solutions International Inc., Houston. 30 pp. + app.

Farmayan, W. 2011. Update modeling of Alaska exploratory well drilling discharges. Shell Global Solutions International Inc., Houston. 30 pp. + app..

Fay, F.H. 1982. Ecology and biology of the Pacific walrus (*Odobenus rosmarus divergens*). North American Fauna 74. U.S. Fish and Wildlife Service, Washington, DC. 279 pp.

Fay, R.R. 1988. Hearing in vertebrates: a psychophysics databook. Winnetka, Illinois: Hill-Fay Associates.

Fay, F.H. and J.J. Burns. 1988. Maximal feeding depths of walruses. Arctic 413:239-240.

Fay, F., B. Kelly, P. Gehnrich, J. Sease, and A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. OCS Study MMS 86-002, Final Report of the Principal Investigators (1986) Volume 37:231-376, National Oceanic Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Anchorage, Alaska.

Fechhelm, R., P. Craig, J. Baker, and B. Galloway. 1984. Fish distribution and use of nearshore waters in the northeastern Chukchi Sea. Final Reports of Principal Investigators, Volume 32 (June 1985):121-297, NOAA Outer Continental Shelf Environmental Assessment Program, Juneau, AK.

Feder, H., A. Naidu, J. Hameedi, S. Jewett, and W. Johnson. 1989. The Chukchi Sea continental shelf: benthos environmental interactions. Final Report to NOAA-Ocean Assessment Division (Anchorage), and Institute of Marine Science, University of Alaska Fairbanks. 247 pp + app.

Finley, K.J. and R.A. Davis. 1984. Reactions of beluga whales and narwhals to ship traffic and ice-breaking along ice edges in the eastern Canadian High Arctic, 1982-1984: An overview. Environmental Studies No. 37. Ottawa, Ontario, Canada: Canadian Dept. of Indian Affairs and Northern Development, Northern Environmental Protection Branch, Northern Affairs Program, 42 pp.

Finley, K.J., G.W. Miller, R.A. Davis, and C.R. Greene. 1990. Reactions of belugas (*Delphinapterus leucas*) and Narwhals (*Monodon monoceros*) to ice-breaking ships in the Canadian high Arctic. Canadian Bulletin Fisheries and Aquatic Science 224:97–117.

Finneran, J.J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal Acoustical Society of America 111(6):2929-2940.

Finneran, J. J. and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes (SPAWAR Systems Command Technical Report #1913). San Diego: U.S. Navy.

Fischer, J.B. and W.W. Larned. 2004. Summer distribution of marine birds in the western Beaufort Sea. Arctic. 57:143-159.

Fischer, J.B., T.J. Tiplady, and W.W. Larned. 2002. Monitoring Beaufort Sea waterfowl and marine birds, aerial survey component. Outer Continental Shelf study, MMS 2002–002. U.S. Fish and Wildlife Service, Anchorage Alaska.

Fischbach, A.S., D.H. Monson, and C.V. Jay. 2009. Enumeration of Pacific walrus carcasses on beaches of the Chukchi Sea in Alaska following a mortality event, September 2009. Open-File Report 2009–129. U.S. Department of the Interior, U.S. Geological Survey. 10 pp.

Fjeld, P., G. Gabrielson, and J. Orbak. 1988. Noise from helicopters and its effect on a colony of Brunnich's gullemoty (*Uria lomvia*) on Svalbard, Norwegian Polar Institute, Rolfstanangveien.

Foote, A.D., R.W. Osborne, and A.R. Hoelzel. 2004. Whale-call response to masking boat noise. Nature 428:910.

Frankel, A.S. 2005. Gray whales hear and respond to a 21-25 kHz high-frequency whale finding sonar [ABS]. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA, 12-18 December 2005.

Frankel, A.S., and C.W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae*, in Hawai'i. Canadian Journal of Zoology 76:521-535.

Frost, K. and L. Lowry. 1983. Demersal fishes and invertebrates trawled in the northeastern Chukchi and Western Beaufort Seas, 1976-1977. National Oceanic and Atmospheric Administration National Marine Fisheries Service Technical Report SSRF- 764. U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service. Seattle, Washington.

Frost, K. and L. Lowry. 1984. Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea. In The Alaskan Beaufort Sea, Ecosystems and Environments. Peter W. Barnes, Donald M. Schell, and Erk Reimnitz, eds. Orlando: API.

Frost, K. and L. Lowry. 1990. Use of Kasegaluk Lagoon by marine mammals. pp 93-100 *in*: Third Information Transfer Meeting Conference Proceedings, OCS Study MMMS 90-0041, Alaska OCS Region, Minerals Management Service, Anchorage, AK. 223 pp.

Frost, K., L. Lowry, and G. Carroll. 1993. Beluga and spotted seal use of a coastal lagoon system. Arctic 46(1):8-16.

Fuller, A., and J. George. 1997. Evaluation of subsistence harvest data from the North Slope Borough 1993 census for eight North Slope villages: for the calendar year 1992. Second Edition. Department of Wildlife Management, North Slope Borough, Barrow, Alaska.

Funk, D.W., R. Rodrigues, D.S. Ireland, and W.R. Koski (eds.). 2007. Joint monitoring program in the Chukchi and Beaufort Seas, July-November 2006. LGL Alaska Report P891-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., Bioacoustics Research Program, Cornell University, and Bio-Wave Inc. for Shell Offshore, Inc., ConocoPhillips Alaska, Inc., and GX Technology, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 316 p. plus Appendices.

Funk, D.W., D. Hannay, D. Ireland, R. Rodrigues, and W.R. Koski. 2008. Marine mammal monitoring and mitigation during open–water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort seas, July–November 2007: 90–day Report. LGL Report P969–1. Rep. from LGL Alaska Research Associates, Inc., LGL Ltd., and JASCO Research Ltd., for Shell Offshore Inc., the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service.

Funk., D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2009. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 488 p. plus Appendices.

Funk, D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint monitoring program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Applied Sciences, for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 462 pp. plus Appendices.

Funk, D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2011a. Joint monitoring program in the Chukchi and Beaufort seas, open-water seasons, 2006–2009. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Applied Sciences, for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 462 pp. plus Appendices.

Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2011b. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and

Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Gall, A. and B. Day. 2009. Distribution and abundance of seabirds in the northeastern Chukchi Sea, 2008. Report prepared for ConocoPhillips Alaska, Inc., and Shell Exploration & Production Company, Anchorage, AK by ABR, Inc. – Environmental Research & Services, Fairbanks, AK. 55 pp.

Gall A. and B. Day. 2010. Distribution and abundance of seabirds in the northeastern Chukchi Sea, 2008 and 2009. Report prepared for ConocoPhillips Alaska, Inc., and Shell Exploration & Production Company, Anchorage, AK by ABR, Inc. – Environmental Research & Services, Fairbanks, AK. 68 pp.

Gallagher, M., K. Brewer, and J. Hall. 1992a. Site specific monitoring plan Galahad Prospect: final report. Report prepared for Amoco Production Company by Coastal and Offshore Pacific Corp., Walnut Creek, CA. 50 pp.

Garlich-Miller, J. J. MacCracken, J. Snyder, R. Meehan, M. Myers, J. Wilder, E. Lance and A. Matz. 2011. Status review of the Pacific walrus (*Odobenus rosmarus divergens*). U.S. Fish and Wildlife Service, Fairbanks Field Office, Fairbanks, AK. 139 pp. + app.

George, J.C., L.M. Philo, K. Hazard, D. Withrow, G.M. Carroll, and R. Suydam. 1994. Frequency of killer whale (*Orcincus orca*) attacks and ship collisions based on scarring on bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Sea stock. Arctic 47(3):247-255.

Gilbert, J.R., G.A. Fedoseev, D. Seagars, E. Razlivalov, and A. LaChugin. 1992. Aerial census of Pacific Walrus, 1990. USFWS R7/MMM Technical Report 92-1. 33 pp.

Gillispie, J.G., R.L. Smith, L.E. Barbour, and W.E. Barber. 1997. Distribution, abundance, and growth of arctic cod in the northeastern Chukchi Sea. pp. 81-89 .In Fish Ecology in Arctic North America. Edited by J.B. Reynolds. American Fisheries Society Symposium No. 19.

Gollop, M.A., Goldsberry, J.R. and R.A. Davis. 1974a. Disturbance studies of breeding black brant, common eiders, glaucous gulls, and arctic terns at Nunaluk Spit and Phillips Bay, Yukon Territory, July 1972. pp.153-200 *in*: W.W.H. Gunn and J.A. Livingston (eds.) Arctic Gas Biological Report Series Volume 14.

Gollop, M.A., Goldsberry, J.R., and R.A. Davis. 1974b. Aircraft disturbance to molting sea ducks, Herschel Island, Yukon Territory, August, 1972. pp.202-232 *in*: W.W.H. Gunn and J.A. Livingston (eds.) Arctic Gas Biological Report Series Volume 14.

Gradinger, R., K. Meiners, G. Plumley, Q. Zhang, and B. Bluhm. 2005. Abundance and composition of the sea-ice Meiofauna in off-shore pack ice of the Beaufort Gyre in summer 2002 and 2003. Polar Biology. 28:171-181.

Greene, C. 1985. Characteristics of waterborne industrial noise, 1980-1984. pp. 197-253 in: W. Richardson (ed.) Behavior, disturbance responses and distribution of bowhead whales Balaena mysticetus in the Eastern Beaufort Sea, 1980-1984. OCS Study MMS 85-0034. Rep. prepared by LGL Ecol. Res. Assoc. Inc., Bryan, TX, for UDOI Minerals Management Service, Reston, VA. 306 pp.

Hall, J., M. Gallagher, K. Brewer, P. Regos, and P. Isert. 1994. Arco Alaska, Inc. 1993 Kuvlum exploration prospect site specific monitoring program final report. Report prepared for Arco Alaska, Inc. by Coastal and Offshore Pacific Corp., Walnut Creek, CA. 218 pp.

Harris, G.P. 1986. Phytoplankton ecology: structure function and fluctuation. Chapman and Hill. London, England.

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

Hart, J. 1983. Pacific fishes of Canada. Bulletin of Fisheries Research Board of Canada 180. 740p.

Hartline, K., P. Lenz, and C. Herren. 1996. Physiological and behavioural studies of escape responses in Calanoid copepods. Marine and Freshwater Behavior and Physiology 27:199-212.

Hawkins, A.D. 1981. The hearing abilities of fish. pp.109-133 *in*: W.N. Tavolga, A.N. Popper and R.R. Fay (eds.) Hearing and sound communication in fishes. Springer. New York.

Henry, C.J., D.D. Rudis, T.J. Roffe, and E. Robinson-Wilson. 1995. Contaminants and sea ducks in Alaska and the circumpolar region. Environmental Health Perspectives 103:41-49 (Suppl. 4).

Holland, T.H., J.R. Chambers, and R.R. Blackman. 1980. Effects of dredging and filling for beach erosion control on fishes in the vicinity of Lido Key, Florida. US Army Engineer District, Jacksonville, Fla.

Holmes, C.E. 2001. Tanana River valley archaeology circa 14,000 to 9000BP. Arctic Anthropology. 38(2):154-170.

Hopcroft, R., J. Questel, and C. Clarke-Hopcroft. 2009. Oceanographic assessment of the planktonic communities in the Klondike and Burger survey areas of the Chukchi Sea: report for survey year 2008.

Hopcroft, R., J. Questel, and C. Clarke-Hopcroft. 2010. Oceanographic assessment of the planktonic communities in the Klondike and Burger survey areas of the Chukchi Sea: report for survey year 2009.

Horner, R.A., K.O. Coyle, and D.R. Redburn. 1974. Ecology of the plankton of Prudhoe Bay, Alaska. IMS Report No. R76-2, Sea Grant Report No. 73-15. University of Alaska, Institute of Marine Science.

Hurley, G. and J. Ellis. 2004. Environmental effects of exploratory drilling offshore Canada: Environmental effects of monitoring data and literature review. Final Report. Regulatory Advisory Committee, Canada Environmental Assessment Agency, Ottawa, CA. 114 pp.

IMG-Golder Corporation. 2004. Review of potential effects of dredging in the Beaufort Sea. Inuvik, Canada. 81 p.

Ireland, D., D. Hannay, R. Rodrigues,H. Patterson, B. Haley, A. Hunter, M. Jankowski, and D. W. Funk. 2007. Marine mammal monitoring and mitigation during open water seismic exploration by GX Technology, Inc. in the Chukchi Sea, October—November 2006: 90–day report. LGL Draft Rep. P891–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., King City, Ont., and JASCO Research, Ltd., Victoria, B.S., Can. for GX Technology, Inc., Houston, TX, and Nat. Mar. Fish. Serv., Silver Spring, MD. 119 p.

Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, D. Hannay. (eds.) 2009a. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-day report. LGL Rep. P1049-1. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc, Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 277 pp, plus appendices.

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

Jangaard, P.M. 1974. The capelin (*Mallotus villosus*): biology, distribution, utilization, and composition. Bulletin of the Fisheries Research Board of Canada No. 186. 70 pp.

Jay, C.V. and S. Hills. 2005. Movements of walruses radio-tagged in Bristol Bay, Alaska. Arctic 58:192-202.

Johnson, S.R. 1993. An important early-autumn staging area for Pacific Flyway brant: Kasegaluk Lagoon, Chukchi Sea, Alaska. Journal of Field Ornithology 64: 539-548.

Johnson, J., and M. Daigneault. 2008. Catalog of waters important for spawning, rearing, or migration of Anadromous fishes – Interior Region, Effective June 2, 2008. Special Publication No. 08-04, Alaska Department of Fish and Game, Anchorage.

Johnson, S.R. and D.R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage, AK.

Johnson, S.R., K.J. Frost, and L.F. Lowry. 1992. Use of Kasegaluk Lagoon, Chukchi Sea, Alaska, by marine birds and mammals, Volume I: An overview. OCS Study MMS 92-0028. USDOI, Minerals Management Service, Alaska OCS Region Anchorage, AK. pp. 4-56.

Johnson, S.R., D. Wiggins, and P. Wainwright. 1993. Late summer abundance and distribution of marine birds in Kasegaluk Lagoon, Chukchi Sea, Alaska. Arctic. 46(3) 212-227.

Johnson, J., R.B. Lanctot, B.A. Andres, J.R. Bart, S.C. Brown, S.J. Kendall, and D.C. Payer. 2007. Distribution of breeding shorebirds on the Arctic coastal plain of Alaska. Arctic. 60:277-293.

Kertell, K. 1991. Disappearance of the Steller's Eider from the Yukon-Kuskokwim Delta, Alaska. Arctic. 44: 177-1 87.

Kinney, P.J., ed. 1985. Environmental characterization and biological utilization of Peard Bay. OCS Study MMS 85-0102. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK. pp. 97-440.

Kosheleva, V. 1992. The impact of airguns used in marine seismic exploration on organisms living in the Barents Sea. Fisheries and Offshore Petroleum Exploitation, 2nd Annual International Conference, Bergen, Norway.

Koski, W. and S. Johnson. 1987. Behavioral studies and aerial photogrammetry. Section 4 in Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986. Report by LGL Limited, King City, Ont. And Greeneridge Sciences Inc., Santa Barbara, CA for Shell Western E & P Inc., Anchorage, AK 371 pp.

Koski, W.R., D.W. Funk, D.S. Ireland, C. Lyons, A.M. Macrander, and I. Voparil. 2008. Feeding by bowhead whales near an offshore seismic survey in the Beaufort Sea. IWC Paper SC/60/E14 presented to the International Whaling Commission, Santiago, Chile June 2008. 14 pp.

Lacroix, D.L., Lanctot, R.B., Reed, J.A., and T.L. McDonald. 2003. Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska. Canadian Journal of Zoology 81:1862-1875.

Larned, W. 2007. Steller's Eider spring migration surveys southwest Alaska 2007. U.S. Fish and Wildlife Service, Migratory Bird Management Office, Anchorage, AK.

Larned, W., G.R. Balogh, and M.R. Petersen. 1995. Distribution and abundance of spectacled eiders (Somateria fischeri) in Ledyard Bay, Alaska. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK. 11pp.

Larned, W., R. Stehn, and R. Platte. 2005. Eider breeding population survey Arctic coastal plain, Alaska, 2005. U.S. Fish and Wildlife Service, Migratory Bird Management. Anchorage, AK.

Larned, W., R. Stehn, and R. Platte. 2007. Waterfowl breeding population survey Arctic coastal plain, Alaska 2007. U.S. Fish and Wildlife Service, Migratory Bird Management, Waterfowl Management Branch, Soldotna and Anchorage, AK.

Larned, W., R. Stehn, and R. Platte. 2012. Waterfowl breeding population survey Arctic coastal plain, Alaska 2011. U.S. Fish and Wildlife Service, Migratory Bird Management, Waterfowl Management Branch, Soldotna and Anchorage, AK.

LaSalle, M.W., D.G. Clarke, J. Homziak, J.D. Lunzand, and T.J. Fredette. 1991. A framework for assessing the need for seasonal restrictions on dredging and disposal operations. Technical Report D-91-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lehnhausen, W. and S. Quinlan. 1981. Bird migration and habitat use at Icy Cape, Alaska. Unpublished Report. U.S. Fish and Wildlife Service, Fairbanks, Alaska. 298 pp.

Lesage, V., C. Barrete, and M. Kingsley. 1993. The effect of noise from an outboard motor and a ferry on the vocal activity of beluga (*Delphinapterus leucas*) in the St Lawrence estuary, Canada. P. 70 in Abstracts 10th Biennial Conference on Maroen Mammals, Galveston, TX. 130 pp.

LGL and Greeneridge. 1986. Reactions of beluga whales and narwhals to ship traffic and ice-breaking along ice edges in the eastern Canadian High Arctic: 1982-1984. Environ. Study 37, Indian & Northern Affairs, Ottawa, Ont. 301 pp.

Lowry, L.F. 1993. Foods and feeding ecology. pp. 201-238 *in*: J.J. Burns, J.J. Montague, and C.J. Cowles (eds.) The bowhead whale. Society Marine Mammalogists, Special Publication No. 2.

Lowry, L., K. Frost, and J. Burns. 1980. Trophic relationships among ice-inhabiting phocid seals and function nally related marine mammals in the Chukchi Sea: final report of Chukchi Sea activities. Contract No. 03-5-022-53. Alaska Department of Fish and Game, Fairbanks, Alaska. 58 pp.

Lowry, L.F. and K.J. Frost. 1981. Distribution, growth, and foods of arctic cod (*Boreogadus saida*) in Bering, Chukchi, and Beaufort Seas. Canadian Field Naturalist. 95:186-191.

Lysne, L., E. Mallek, and C. Dau. 2004. Near shore surveys if Alaska's Arctic coast, 1999-2003. U.S. Fish and Wildlife Service. Division of Migratory Bird Management, Fairbanks, Alaska 12 pp. + app.

Malme, C., P. Miles, C. Clark, P. Tyack, and J. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 Migration. BBN Rep. 5586. Rep. from Bolt Beranek &

Newman Inc., Cambridge, MA, for USDOI Minerals Management Service, Anchorage, AK. Var. pages. NTIS PB86-218377.

Mate, B.R., and J.T. Harvey. 1987. Acoustical deterrents in marine mammals conflicts with fisheries. Workshop, 17-18 February, 1986, Newport Oregon. Oregon State University, Publ. No. ORESU-W-86-001, 116 p.

Martin, P. 1997. Personal Communication as cited in U.S. Department of Interior, Bureau of Land Management, 2003, Biological assessment for threatened and endangered species with respect to the proposed Northwest National Petroleum Reserve-Alaska Integrated Activity Plan. U.S. Fish and Wildlife Service, Anchorage, Alaska

McCauley, R.D. 1994. Seismic surveys. pp. 19-122 *in*: M. Swan, I.M. Neff, and P.C. Young, (eds.) Environmental implications of offshore oil and gas development in Australia-the finding of an independent review. Australian Petroleum Exploration Assoc., Sydney, AU.

McManus, D., J. Kelly, and J. Creager. 1969. Continental shelf sedimentation in an arctic environment. Geological Society of America Bulletin 80:1961-1984.

Mecklenburg, C.W., T.A. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, MD.

Messieh, S.N., D.J. Wildish, and R.H. Peterson. 1981. Possible impact from dredging and spoil disposal on the Miramichi Bay herring fishery. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1008.

Mitson, R.B., and H.P. Knudsen. 2003. Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources 16: 255–263.

MMS. 1991. Alaska outer continental shelf Chukchi Sea oil & gas lease sale 126, Final Environmental Impact Statement. US Department of the Interior, Minerals Management Service, Alaska OCS Region, OCS EIS/EA MMS 90-0095.

MMS. 2006a. Chukchi sea planning area oil and gas lease sale 193 draft Environmental Impact Statement. OCS EIS/EA MMS 2006-060. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK. Vols. 1-3.

MMS. 2006b. Biological evaluation of Steller's eider (*Polysticta stelleri*), spectacled eider (*Somateria fischeri*), and Kittlitz's murrelet (*Brachyramphus brevirostris*) for seismic surveys in the northeast Chukchi Sea and western Beaufort Sea Planning Areas. March 2006. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK.

MMS. 2006c. Final Programmatic Environmental Assessment: Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006. OCS EIS/EA MMS 2006-038. USDOI Minerals Management Service, Alaska OCS Region, Anchorage. 294 pp.

MMS. 2007a. Seismic surveys in the Beaufort and Chukchi Seas, Alaska. Draft Programmatic Environmental Impact Statement. OCS EIS/EA MMS 2007-001. Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

MMS. 2007b. Chukchi Sea planning area-oil and gas lease sale 193 and seismic surveying activities in the Chukchi Sea. Final Environmental Impact Statement. Vol. I-III. OCS EIS/EA MMS 2007-026. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK.

MMS. 2008a. Beaufort Sea and Chukchi Sera planning areas: oil and gas lease sales 209, 212, 217, and 221: Draft Environmental Impact Statement. OCS EIS/EA MMS 2008-0055, Alaska OCS Region, Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

MMS. 2008b. Final lease stipulations oil and gas lease sale 193 Chukchi Sea. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK. February 6, 2008.

Mohr, J.L., N.J. Wilimovsky, and E.Y. Dawson. 1957. An arctic Alaskan kelp bed. Arctic 19:45-54.

Moore, S.E. 2000. Variability of cetacean distribution and habitat selection in the Alaskan Arctic, autumn 1982-91. Arctic 534:448-460.

Moore, S.E. and R.R. Reeves. 1993. Distribution and movement. pp. 313-386 *in*: J.J. Burns, J.J. Montague, and C.J. Cowles (eds.) The bowhead whale book. Special Publication No. 2, The Society for Marine Mammalogy, Lawrence, KS

Moriyasu, M., R. Allain, K. Benhalima, and R. Claytor. 2004. Effects of seismic and marine noise on invertebrates: a literature review. Canadian Science Advisory Secretariat, Fisheries and Oceans, Canada. 43 pp. Available at HYPERLINK "http://www.dfo-mpo.gc.ca/csas/"http://www.dfo-mpo.gc.ca/csas/.

Mosbech, A. and C. Glahder. 1991. Assessment of the impact of helicopter disturbance on moulting pink-footed geese, *Anser brachyrhynchus*, and barnacle geese, *Branta leucopsis*, in Jameson Land, Greenland. Ardea 79:233-237.

Moulton, V. D., W.J. Richardson, M.T. Williams, and S.B. Blackwell. 2003. Ringed seal densities and noise near and icebound artificial island with construction and drilling. Acoustics Research Letters Online-ARLO 4:112-117.

Moulton, V., W. Richardson, R. Elliot, N. McDonald, and M. Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed Seals (Phoca hispida) of the Alaskan Beaufort Sea. Marine Mammal Science 21(2):217-242.

Naidu, A. 1988. Marine surficial sediments. Section 1.2 *in*: Bering, Beaufort and Chukchi Seas, coastal and ocean zones strategic assessment: data atlas. U.S. Department of Commerce NOAA/SAB, Rockville, MD.

Naidu, A.S., A. Blanchard, J.J. Kelley, J.J. Goering, M.J. Hameed, and M. Baskaran. 1997. Heavy metals in Chukchi Sea sediments as compared to selected circum-arctic shelves. Marine Pollution Bulletin 35:260 – 269. Elsevier Science Ltd. Great Britain.

Nakken, O. 1992. Scientific basis for management of fish resources with regard to seismic exploration. Fisheries and Offshore Petroleum Exploitation 2nd International Bergen, Norway, 6-8 April 1992.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shifts and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America 113:3425-3429.

Nedwell, J. R.,, B. Edwards, A.W.H. Turnpenny, and J. Gordon. 2004. Fish and marine mammal audiograms: a summary of available information." Report 534 R 0214 prepared by Subacoustech Ltd., Hamphire, UK. http://www.subacoustech.com/information/downloads/reports/534R0214.pdf

Neff, J., G. Durell, J. Trefry, and J. Brown. 2010. Environmental studies in the Chukchi Sea 2008: chemical characterization. Volume 1. Final Report August 2010 prepared by Battelle Memorial Institute, Exponent, Inc., Florida Institute of Technology, and Neff & Associates for ConocoPhillips Alaska Inc. and Shell Exploration & Production, Anchorage, AK. 135 pp.

Nelson, C.H., R.L. Phillips, J. McRea Jr., J.H. Barber, Jr., M.W. McLaughlin, and J.L. Chin. 1994. Gray whale and Pacific walrus benthic feeding grounds and sea floor interaction in the Chukchi Sea: MMS 93-0042 U.S. Geological Survey, Menlo Park, California, Technical report for minerals management service/IA No. 14157, OCS Study, 51 p.

NMFS. 2000. Small takes of marine mammals incidental to specified activities; marine seismic-reflection data collection in southern California/Notice of receipt of application. Federal Register 65(60, 28 Mar.):16374-16379.

NMFS. 2011. Effects of oil and gas activities in the Arctic Ocean: Draft environmental impact statement U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

Northern Economics, Incorporated. 2006. North Slope economy, 1965 to 2005. Prepared for the USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK. April 2006.

Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London Series B: Biological Sciences 271:227-231.

NPFMC. 2000. Fishery management plan for the salmon fisheries in the EEZ off the coast of Alaska. North Pacific Fishery Management Council, Anchorage AK. 117 pp. + app.

NPFMC. 2009. Fishery management plan for fish resources of the arctic management area. North Pacific Fishery Management Council, Anchorage AK. 76 pp. + app.

NSB. 2005. North Slope Borough comprehensive plan. Issues, goals, objectives, and policies. Adopted by the NSB Assembly under Ordinance 75-6-48 on Oct. 11, 2005. Prepared by URS Corporation for North Slope Borough Planning Department, Barrow, AK.

Offut, G.C. 1974. Structures for the detection of acoustic stimuli in Atlantic Cod, *Gadus morhua*. Journal of the Acoustical Society of America 56:665-671.

Olsen, K. 1979. Observed avoidance behaviour in herring in relation to passage of an echo survey vessel. ICES Journal of Marine Science 18: 21 pp.

Olsen, K., Angell, J., Pettersen, F., and A. Lovik. 1983. Observed fish reactions to a surveying vessel with special reference to herring, cod, capelin, and polar cod. FAO Fisheries Report 300: 131-138.

Ona, E. 1988. Observations of cod reaction to trawling noise. ICES FAST WG-meeting, Oostende, 20-22.

Ona, E. and O.R. Godo. 1990. Fish reaction to trawling noise; the significance for trawl sampling. Rapp. O-v Reun. Coast. Int. Explor. Mer. 189:159-166.

Ona, E. and R. Toresen. 1988. Reaction of herring to trawl noise. ICES. CM 1988/B-36:1-8.

Ona, E., O. Godø, N. Handegard, V. Hjellvik, R. Patel, and G. Pedersen. 2007. Silent research vessels are not quiet. J. Acoustical Society of America 121(4), April 2007

O'Neill, C. and A. McCrodan 2012. Vessel Sound Source Characterization Measurements at Burger Prospect – Preliminary Report: Shell Drill Program 2012. Version 1.0. Technical report by JASCO Applied Sciences for Shell Exploration Company.

O'Neill, D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) In Blees, M.K., K.G. Hartin, D.S. Ireland, and D. Hannay. (eds.) 2010. Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2010: 90-day report. LGL Rep. P1119. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for by Statoil USA E&P Inc., Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 102 pp, plus appendices.

Ovsyanikov, N. 2003. Polar bears in Chukotka. WWF Arctic Bulletin 2:13-14.

Owens, N.W. 1977. Responses of wintering brent geese to human disturbance. Wildfowl 28:5 14.

Palka, D. and P.S. Hammond. 2001. Accounting for responsive movement in line transect estimates of abundance. Canadian Journal of Fisheries and Aquatic Sciences 58:777-787.

Patenaude, N.J., W.J. Richardson, M.A. Smultea, W.R. Koski, and G.W. Miller. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18(2):309–335.

Patterson, H., S.B. Blackwell, B. Haley, A. Hunter, M. Jankowski, R. Rodrigues, D. Ireland and D. W. Funk. 2007. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–September 2006: 90-day report. LGL Draft Rep. P891-1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Goleta, CA, for Shell

Offshore Inc, Houston, TX, and Nat. Mar. Fish. Serv., Silver Spring, MD. 199 p.Perry, J.A. and D. Renouf. 1987. Further studies of the role of harbor seal (*Phoca vitulina*) pup vocalizations in preventing separation of mother-pup pairs. Canadian Journal of Zoology. 66:934-938.

Petersen, M.R. and P.L. Flint. 2002. Population structure of Pacific common eiders breeding in Alaska. Condor 104:780-787.

Petersen, M.R., W.W. Larned, and D.C. Douglas. 1999. At-sea distributions of spectacled eiders: A 120 year-old mystery resolved. Auk. 116:1009-1020.

Phillips, R.L., T.E. Reiss, E.W. Kempema, E. Reimnitz, E, and B. Richards. 1982. Marine geologic investigations northeast Chukchi Sea, Wainwright to Skull Cliff, in National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaska Continental Shelf: Annual Reports of Principal Investigators for the year ending March, 1982, p. C1-C32.

Phillips, R.L. and T.E. Reiss. 1983. Nearshore marine geologic investigations, Icy Cape to Wainwright, northeast Chukchi Sea. Attachment D in Barnes, P. W., E. Reimnitz, R. E. Hunter, R. L. Phillips, and S. Wolf (eds.). 1983. Geologic processes and hazards of the Beaufort and Chukchi Sea shelf and coastal regions. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 34(1985): 1-322.

Phillips, R.L. and T.E. Reiss. 1985a. Nearshore marine geologic investigations, Icy Cape to Wainwright, northeast Chukchi Sea. Open File Report 84-828, U.S. Geological Survey, Menlo Park, CA. 27 pp.

Phillips, R.L., and T.E. Reiss. 1985b. Nearshore marine geologic investigations, Point Barrow to Skull Cliff, northeast Chukchi Sea. Open File Report 85-50. U.S. Geological Survey, Menlo Park, CA. 22 pp.

Platt, C. and A.N. Popper. 1981. Fine structure and function of the ear. pp. 3-38 *in*: W.N. Tavolga, A.N. Popper, and R.R. Fay (eds.) Hearing and sound communication in fishes. Springer, New York, NY.

Popper, A. 2008. Effects of mid- and high-frequency sonars on fish. Environmental BioAcoustics, LLC Rockville, Maryland 20853 Contract N66604-07M-6056 Naval Undersea Warfare Center Division Newport, Rhode Island February 21, 2008

Powell, A.N., L. Phillips, E.A. Rexstad, and E.J. Taylor. 2005. Importance of the Alaskan Beaufort Sea to king eiders (*Somateria spectabilis*). OSC Study MMS 2005-057. Report prepared by the Coastal Marine Institute, University of Alaska for USDOI Minerals Management Service, Alaska OCS Region, Anchorage.

Quast, J.C. 1972. Preliminary report on fish collected in WEBSEC-70. pp. 203-206. *in*: WEBSEC-70, Pages 203-206. In: WEBSEC-70, and ecological survey in the eastern Chukchi Sea. U.S. Coast Guard, Oceanographic Report No. 50. 206 pp.

Ray, G, E. Mitchell, D. Wartzok, V. Koziki, and R. Maiefski. 1978. Radio tracking of a fin whale (*Balaeoptera physalus*). Science 202(4367):521-524.

Reeves, R.R., R.J. Hofman, G.K. Silber, and D. Wilkinson. 1996. Acoustic deterrence of harmful marine -mammal-fishery interactions: proceedings of a workshop held in Seattle, Washington, 20-22 March 1996. NOAA Technical Memorandum NMFS-OPR-10. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA.

Reiser, C. M, D. W. Funk, R. Rodrigues, and D. Hannay. (eds.) 2010. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore, Inc. in the Alaskan Chukchi Sea, July–October 2009: 90-day report. LGL Rep. P1112-1. Rep. from LGL Alaska Research Associates Inc. and JASCO Research Ltd. for Shell Offshore Inc, Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 104 pp, plus appendices.

Reiser, C.M, D.W. Funk, R. Rodrigues, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish and Wild. Serv., Anchorage, AK. 240 pp, plus appendices.

Rendell, L.E. and J.C.D. Gordon. 1999. Vocal response of long-finned pilot whales (Globicephala melas) to military sonar in the Ligurian Sea. Marine Mammal Science 15(1):198-204.

Richard, P.R., A.R. Martin, and J.R. Orr. 1998. Study of late summer and fall movements and dive behaviour of Beaufort Sea belugas, using satellite telemetry: 1997. MMS OCS Study 98-0016. USDOI Minerals Management Service, Alaska OCS Region, Anchorage. 25 pp.

Richard, P.R., A.R. Martin, and R. Or. 2001. Summer and autumn movements of belugas of the Eastern Beaufort Sea Stock. Arctic 54(3):223–236.

Richardson, W. and K. Finley. 1989. Comparison of behavior of bowhead whales of the Davis Strait and Bering/Beaufort stocks. OCS Study MMS-88-0056. Rep. by LGL Ltd., King City, Ont. for USDOI Minerals Management Service, Herndon, VA. 131 pp.

Richardson, W.J. and C.I. Malme. 1993. Man-made noise and behavioral responses. pp. 631-787p *in*: J.J. Burns, J.J. Montague, and C.J. Cowles (eds.) The bowhead whale book. Special Publication of No.2., The Society for Marine Mammalogy. Lawrence, KS.

Richardson, W.J., M.A. Fraker, B. Wursig, and R.S. Wells. 1985a. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: reactions to industrial activities. Biological Conservation 32(3):195-230.

Richardson, W.J., R.S. Wells, and B. Wursig. 1985b. Disturbance responses of Bowheads, 1980-1984. pp. 255-306 *in*: W.J. Richardson (ed.) Behavior, disturbance responses, and distribution of bowhead whales, *Balaena mysticetus* in the Eastern Beaufort Sea, 1980-84. OCS Study MMS 85-0034. USDOI, Minerals Management Services, Alaska OCS Region, Anchorage, AK.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski, C.I. Malme, G.W. Miller, M.A. Smultea, et al. 1990. Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska—1989 phase. OCS Study MMS 90-0017. (NTIS PB91-105486). LGL Ltd. report prepared for USDOI Minerals Management Service, Herndon, VA. 284 pp.

Richardson, W., C. Greene, W. Koski, M. Smultea, C. Holdsworth, G. Miller, T. Woodley, and B. Wursig. 1991. Acoustic effects of oil production activities on Bowhead and White Whales visible during spring migration near Pt. Barrow, Alaska - 1990 phase. OCS Study MMS 91-0037. USDOI Minerals Management Service, Herndon, VA 311 pp.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995a. Marine mammals and noise. San Diego, CA: Academic Press, Inc. 576 pp.

Richardson, W.J., C.R. Greene, Jr., J.S. Hanna, W.R. Koski, G.W. Miller, N.J. Patenaude, and M.A. Smultea. 1995b. Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska-1991 and 1994 phases: Sound propagation and whale responses to playbacks of icebreaker noise. OCS Study MMS 95-0051. USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK. 392 pp. + app.

Rodgers, J., Jr. and S. Schwikert. 2002. Buffer zone distances to protect foraging and loafing waterbirds from disturbances by personal watercraft and outboard-powered boats. Conservation Biology 16:216-224

Rojek, N.A. 2005. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2004. Technical Report. U.S. Fish & Wildlife Service, Fairbanks, Alaska. 47pp.

Rojek, N.A. 2006. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2005. Technical Report. U.S. Fish and Wildlife Service, Fairbanks, AK. 53 pp.

Rojek, N.A. 2007. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2006. Technical Report. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, AK. 53 pp.

Rojek, N.A. 2008. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2007. Technical Report. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, AK. 45 pp.

Rojek, N.A. and P.D. Martin. 2003. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2003. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, AK. Technical Report. 35 pp.

Rojek, N, M. Parker, H. Carter, and G. McChesny. 2007. Aircraft disturbance and vessel disturbance to common murres *Uria aalge* at breeding colonies in central California 1997-1999. Marine Ornithology 35:61–69.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, et al. 2004. Anthropogenic sound and marine mammal health: Measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61:1124-1134.

Rosa, C. 2009. A summary of dead, stranded bowhead whales reported in the Chukchi and Beaufort seas over the last twenty-five years. IWC paper #SC/61/E12. International Whaling Commission.

Roseneau, D. and D. Herter. 1984. Marine and coastal birds. pp. 81-115 *in*: J.C. Truett (ed) Proceedings of a Synthesis Meeting: The Barrow Arch environment and possible consequences of planned offshore oil and gas development (Sale 85), Girdwood, AK., Oct.30-Nov. 1, 1983. U.S. Department of Commerce, NOAA, OCSEAP and USDOI Minerals Management Service, Alaska OCS Region, Anchorage, AK.

Rostad, A., S. Kaartvedt, T.A. Klevjer, and W. Melle. 2006. Fish are attracted to vessels. ICES Journal of Marine Science 63:1431-1437.

Rugh, D.J., K.W. Shelden, and D.E. Withrow. 1997. Spotted seals, *Phoca lar*gha, in Alaska. Marine Fisheries Review 591:1-18.

Rugh, D., K. Sheldon, D. Withrow, H. Braham, and R. Angliss. 1993. Spotted seal summer distribution and abundance in Alaska. p. 94 *in*: Abstracts of 10th Biennial Conference of Marine Mammals, Galveston, Texas. November 1993. 130 pp.

Sand, O. and H.E. Karlsen. 1986. Detection of infrasound by the Atlantic cod. Journal of Experimental Biology 125:197-204.

Scheifele, P.M., S. Andrews, R.A. Cooper, M. Darre, F.E. Musick, and L. Max. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. Journal of the Acoustical Society of America 117:1486-1492.

Schlundt, C. E., Finneran, J. J., Carder, D. A., and Ridgway, S. H. 2000. Temporary shift in

masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. Journal of Acoustical Society America 107, 3496–3508.

Schmutz, J. 2008. Reproductive demographics, use of marine habitats, and exposure to contaminants of red-throated loons breeding in Alaska. USGS Alaska Science Center, Anchorage, Alaska, accessed on-line at http://www.absc.usgs.gov/research/birds/loons/reproductive_demographics.htm.

Schmutz, J. 2009. Information U.S. Geological Survey website on loons including telemetry studies accessed at http://www.absc.usgs.gov/staff/WTEB/jschmutz/jschmutz.htm on 03/27/09.

Schulberg, S., I. Show, and D. Van Schoik. 1989. Results of the 1987-1988 gray whale migration and landing craft air cushion interaction study program. U.S. Navy Contr. N62474-87-C-8669. Report from SRA Southwest Research Assoc., Cardiff, CA for the Naval Facilities Engineering Command, San Bruno, CA 45 pp.

Scientific Research Association. 1988. Results of the 1986-1987 gray whale migration and landing craft air cushion interaction study program. U.S. Navy Contr. N62474-86-M-0942. Rep. from SRA Southwest Research Assoc., Cardiff, CA for the Naval Facilities Engineering Command, San Bruno, CA 31 pp.

Sea Duck Joint Venture. 2003. Long-tailed duck (*Clangula hyemalis*). Sea Duck Information Series, Info Sheet# 10, October 2010. Sea Duck Joint Venture online at http://www.seaduckjv.org/.

Sea Duck Joint Venture. 2004a. King eider (*Somateria spectabilis*). Sea Duck Information Series, Info Sheet# 5, March 2004. Sea Duck Joint Venture online at http://www.seaduckjv.org/.

Sea Duck Joint Venture. 2004b. Common eider (*Somateria mollissima*). Sea Duck Information Series, Info Sheet# 5, March 2004. Sea Duck Joint Venture online at http://www.seaduckjv.org/.

Searing, G.F., E. Kyut, W.J. Richardson, and T.W. Barry. 1975. Seabirds of the southeastern Beaufort Sea: aircraft and group observations in 1972 and 1974. Beaufort Sea Technical Report 3B, Department of Environment, Victoria, British Columbia, Canada.

Shell. 2011a. Revised Chukchi Sea exploration plan OCS Lease Sale 193, Chukchi Sea, Alaska, exploration drilling program Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915. Submitted to U.S. Department of Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska OCS Region by Shell Gulf of Mexico Inc., Anchorage, AK.

Shell. 2011b. Environmental impact analysis, Appendix F in Shell (2011a) Revised Chukchi Sea exploration plan OCS Lease Sale 193, Chukchi Sea, Alaska, exploration drilling program Posey Area Blocks 6714, 6762, 6764, 6812, 6912, 6915. Submitted to U.S.

Department of Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska OCS Region by Shell Gulf of Mexico Inc., Anchorage, AK.

Shell. 2012. Application for incidental harassment authorization fpr the non-lethal taking of whales and seals in conjunction with a proposed open water survey program in the Beaufort and Chukchi Sea, Alaska, during 2013. Shell Exploration and Production, Inc., Anchorage, AK 85 pp.

Shell. 2013. Application for incidental harassment authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water marine survey program in the Beaufort and Chukchi Seas, Alaska during 2013. Prepared by Shell Exploration and Production, Inc., Anchorage, AK.85 pp.

Shell Global Solutions. 2009. Draft update: modeled drill mud impacts from an exploratory drilling campaign in the Chukchi Sea and Beaufort Sea, Alaska. Draft report prepared by Ian Voparil at Shell Global Solutions, Houston, Texas for Shell Exploration and Production, Anchorage, Alaska 68 pp.

Shepro, C.E., D.C. Maas, and D.G. Callaway. 2003. North Slope Borough 2003 economic profile and census report. Department of Planning and Community Services. IX. Barrow, Alaska.

Slaney, F.F. and Company Limited (Slaney). 1977. Biophysical data appendix, artificial island sites. 1976 summer aquatic studies, Arnak L-30 artificial island site and Tuft Point borrow site. Report prepared for Imperial Oil Ltd., Calgary, AB. 136 p.

Sound Enterprises and Associates, LLC. 2008. Chukchi village interview program. Unpublished report prepared by Sound Enterprises and Associates LLC, Bainbridge Island, WA for Shell Exploration and Production Company, Anchorage, AK.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.K. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Special Issue of Aquatic Mammals 33(4):412-522.

Springer, A., E. Murphy, D. Roseneau, and M. Springer. 1982. Population status, reproductive ecology, and trophic relationships of seabirds in northwestern Alaska. Final Report by LGL Alaska Research Associates, Inc. for the Outer Continental Shelf Environmental Assessment Program, Research Unit 460, April 1982. 243 pp.

SRA. 1988. Results of the 1986-1987 gray whale migration and landing craft, air cushion ineraction study program. U.S. Navy Contract N62474-86-M-0942. Report from SRA Southwest Research Associates, Cardiff by the Sea, for Vaval Facilities Command, San Bruno, CA. 31 pp.

Stemp, R. 1985. Observation on the effects of seismic exploration on seabirds. pp. 217-233 *in*: G.D. Greene, F.R. Englehardt, and R.J. Paterson (eds.) Proceedings of the workshop on effects of explosives use in the marine environment, January 29 to 31, 1985. Technical

Report No. 5. Halifax Energy, Mines and Resources Canada and Northern India Affairs Canada, Canada Oil and Gas Lands Administration, Environmental Branch, Ottawa.

Sternfield, M. 2004. Ice seals in the National Marine Fisheries Service Alaska Region (NMFS AKR) stranding records: 1982-2004. USDOC, NOAA, NMFS Alaska Region, Juneau, Alaska.3 pp.

Stewart, B.S., W.E. Evans, and F.T. Awbrey. 1982. Effects of man-made water-borne noise on the behaviour of beluga whales, *Delphinapterus leucas,* in Bristol Bay, Alaska. HSWRI Technical Report 82-145. Report to the US National Oceanic and Atmospheric Administration, Juneau, Alaska by Gybbs/Sea World Research Institute, San Diego, California. 29pp.

Stoker S.W. 1981. Benthic invertebrate macrofauna of the eastern Bering/Chukchi continental shelf. pp. 1069-1090 *in*: D.W. Hood and J.A. Calder (eds). The eastern Bering Sea shelf: oceanography and resources. Volume 2. University of Washington Press, Seattle.

Stoker, S. 1983. Subsistence harvest estimates and faunal potential at whaling villages in northwestern Alaska. Appendix A *in*: Subsistence study of Alaska Eskimo whaling villages. USDOI Minerals Management Service, Washington, D.C.

Suydam, R.S., D.L. Dickson, J.B. Fadley, and L.T. Quakenbush. 2000. Population declines of king and common eiders of the Beaufort Sea. Condor 102:219-222.

Suydam, R.S., J.C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2008. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2007. Paper SC/60/BRG10. International Whaling Commission, Cambridge, UK.

Tavolga, W.N., A.N. Popper, and R.R. Fay. 1981. Hearing and sound communication in fishes. Springer-Verlag, New York. 608 pp.

TERA. 1996. Distribution and abundance of spectacled eiders in the vicinity of the Prudhoe Bay, Alaska. Report prepared by Troy Ecological Research Associates, Anchorage, Alaska for BP Exploration (Alaska) Inc., Anchorage, Alaska.

Terhune, J.M. 1981. Influence of loud vessel noises on marine mammal hearing and vocal communication. In The Question of Sound from Icebreaker Operations. Proceedings of a Workshop. N.M. Peterson, ed. Toronto, Ontario, Canada: Arctic Pilot Project, Petro-Canada.

Thomas, T., W.R. Koski and D.S. Ireland. 2010. Chukchi Sea nearshore aerial surveys. Chapter 4 *in*: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 pp. + app.

Thorsteinson, L.K, L.E. Jarvela, and D.A. Hale. 1991. Arctic fish habitat use investigations: Nearshore studies in the Alaskan Beaufort Sea, summer 1990. Annual Report. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Services, Anchorage, AK. 166 pp.

Troy, D.M. 2000. Shorebirds. pp. 277-303 *in*: J.C. Truett and S.R. Johnson (eds.) The natural history of an arctic oilfield: Development and the biota. Academic Press, San Diego, CA.

Troy, D.M. 2003. Molt migration of spectacled eiders in the Beaufort Sea region. Report prepared by Troy Ecological Research Associates, Anchorage, Alaska, for British Petroleum Exploration-Alaska, Inc. Anchorage, Alaska. 17 pp.

USACE. 2000a. Ouzinke Harbor trip report, Steller's eider Survey No. 1 and 2. Unpublished memorandum for the Record. CEPOA-EN-CW-ER. Alaska District, Anchorage.

USACE. 2000b. Sand Point trip report, Steller's eider Survey No. 1, 2, and 3. Unpublished memorandum for the Record. CEPOA-EN-CW-ER. Alaska District, Anchorage.

USACE. 2000c. Unalaska trip report, Steller's eider Survey No. 1 of 4. Unpublished memorandum for the Record. CEPOA-EN-CW-ER. Alaska District, Anchorage.

USACE. 2000d. Biological Assessment of Steller's eider *Polysticta stelleri* (Pallas) for Harbor Construction at Sand Point, Alaska. Unpublished memorandum for the Record. CEPOA-EN-CW-PF. Alaska District, Anchorage.

USFWS. 1996. Spectacled eider recovery plan. U.S. Fish and Wildlife Service, Anchorage, AK.

USFWS. 2000. Beringian seabird colony catalog. Computer Database. U.S. Fish and Wildlife Service, Migratory Bird Management. Anchorage, AK.

USFWS. 2002. Spectacled eider fact sheet. U.S. Fish and Wildlife Service, Anchorage, AK. October 2002.

USFWS, 2004. Endangered and threatened wildlife and plants; Review of species that are candidates or proposed for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions; notice of review; Proposed Rule. U.S. Department of the Interior, Fish and Wildlife Service. Federal Register / Vol. 69, No. 86 / Tuesday, May 4, 2004.

USFWS. 2005. Alaska's threatened and endangered species. Unpublished report, Anchorage Fish and Wildlife Field Office, Anchorage, Alaska. March 2005.

USFWS. 2007. Biological opinion Chukchi Sea planning area oil and gas lease sale 193 and associated seismic surveys and exploratory drilling. U.S. Fish and Wildlife Service, Alaska

USFWS. 2008. Programmatic biological opinion for polar bear (Ursus maritimus) on Chukchi Sea Incidental Take Regulations. June 2008. U. S. Fish and Wildlife Service, Fairbanks, AK. 74 pp.

USFWS. 2009. Species assessment and listing priority assignment form: Kittlit's murrelet. U.S. Fish and Wildlife Service, Anchorage, AK at http://ecos.fws.gov/docs/candforms_pdf/r7?BOAP_V01.pdf.

USFWS. 2010a. Pacific walrus (*Odobenus rosmarus divergens*): Alaska stock. Final stock assessment report. Available at http://alaska.fws.gov/ fisheries/mmm/walrus/reports.htm.

USFWS. 2010b. Polar bear (*Ursus maritimus*): Chukchi/Bering Seas stock. Final stock vailable assessment report. Available at http://alaska.fws.gov/fisheries/mmm/stock/final_cbs_polar_bear_sar.pdf.

USFWS. 2010c. Polar bear (Ursus maritimus): Southern Beaufort Sea stock. Final stock assessment report. Available at http://alaska.fws.gov/fisheries/mmm/stock/final_sbs_polar_bear_sar.pdf.

USFWS. 2010d. Candidate assessment Kittlitz's murrelet: U.S. Fish and Wildlife Service Species Assessment and listing priority assessment form. Dated May 2010. U.S. Fish and Wildlife Service, Anchorage Field Office, Anchorage, AK. 46 pp.

USFWS. 2010e. 50 CFR Part 17 Endangered and threatened wildlife and plants; designation of critical habitat for the polar bear (Ursus maritimus) in the United States; Final Rule. Federal Register 75(234.):16374-16379 7 December 2010.

USFWS. 2012. Draft environmental assessment: proposed rule to authorize the incidental take of small numbers of Pacific walruses *(Odobenus rosmarus divergens)* and Polar Bears (*Ursus maritimus*) During Oil and Gas Industry Exploration Activities in the Chukchi Sea. USDOI, U.S. Fish and Wildlife Service, October 17, 2012

USGS. 2008. Wandering wildlife satellite and radio telemetry tracking wildlife across the Arctic: long tailed duck. Viewed online at http://alaska.usgs.gov/science/biology/wandering_wildlife/.

USGS. 2009. Wandering wildlife satellite and radio telemetry tracking wildlife across the Arctic: common eider. Viewed online at http://alaska.usgs.gov/science/biology/wandering_wildlife/ .

Van Vliet, G.B. and M. McAllister. 1994. Kittlitz's murrelet: the species most impacted by direct mortality from the Exxon Valdez oil spill? Pacific Seabirds 21:5-6.

Ward, J.G. and E. Pessah. 1986. Marine mammal observations in the Beaufort Sea, 1985 season, with a discussion of bowhead whales sightings, 1976-1985. Dome/Canmar Tech. Rep. Dome Petrol. Ltd., Calgary, Alb. 54 p.

Ward, D. and R. Stehn. 1989. Response of brant and other geese to aircraft disturbances at Izemek Lagoon, Alaska. OSC Study 90-0046, report prepared by U.S. Fish and Wildlife Service, Alaska for USDOI Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

Warner, G., and A. McCrodan. 2011. Underwater Sound Measurements. (Chapter 3) *In*: Hartin K.G., L.N. Bisson, S.A. Case, D.S. Ireland, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2011: 90-day report. LGL Rep. P1193. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Statoil USA E&P Inc., Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 202 pp, plus appendices.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology 49:1-15.

Warner, G. C. Erbe, and D. Hannay. 2010. Underwater sound measurements. (Chapter 3) In: Reiser, C. M, D. W. Funk, Rodrigues, and D. Hannay. (eds.). 2010. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore, Inc. in the Alaskan Chukchi Sea, July–October 2009: 90-day report. LGL Rep. P1112-1. Rep. from LGL Alaska Research Associates Inc. and JASCO Research Ltd. for Shell Offshore Inc, Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 104 pp, plus appendices.

Wartzok, D., W. Watkins, B. Wursig, and C. Malme. 1989. Movements and behavior of bowhead whales in response to repeated exposures to noises associated with industrial activities in the Beaufort Sea. Report by Purdue University, Fort Wayne, Indiana, for Amoco Production Company, Anchorage, AK. 228 pp.

Watson, G. and G. Divoky. 1972. Pelagic bird and mammal observations in the Eastern Chukchi Sea, Early Fall 1970. in An Ecological Survey in the Eastern Chukchi Sea, September-October 1970. U.S. Coast Guard Oceanographic Report 50.

Webb, C., and N. Kempf. 1998. The impact of shallow-water seismic in sensitive areas. Society of Petroleum Engineers Technical Paper SPE 46722. Caracas, Venezuela.

Werner, I, I. Johanna, and H. Schunemann. 2007. Sea-ice algae in arctic pack ice during late winter. Polar Biology 30(11):1493-1504.

Wiese, K. 1996. Sensory capacities of Euphausiids in the context of schooling. Marine and Freshwater Behavior and Physiology 28:183–194.

Wilber, P. 1992. Case studies of the thin-layer disposal of dredged material – Fowl River, Alabama. In: Environmental Effects of Dredging, Vol. D-92-5. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Wilber, D.H. and D.G. Clark. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management. 21:855–875.

Wildish D.J. and J. Power. 1985. Avoidance of suspended sediments by smelt as determined by a new single fish behavioral bioassay. Bulletin of Environmental Contamination and Toxicology 31(1):770-774.

Wilson, B. and L.M. Dill. 2002. Pacific herring respond to simulated odontocete echolocation calls. Canadian Journal of Fisheries and Aquatic Science 59:542-553.

Wong, C.K. 1996. Effects of diazinon on the demographic parameters of *Moina macrocopa*. Water, Air and Soil Pollution 393:393-399.

Woodby, C.A. and G.J. Divoky. 1982. Spring migration of eiders and other waterfowl and Point Barrow, Alaska. Arctic 35(3):403-410.

Attachment A

Marine Mammal Monitoring and Mitigation Plan (4MP)
Geophysical and Geotechnical Surveys Alaskan Chukchi and Beaufort Seas 2013

Marine Mammal Monitoring and Mitigation Plan

for

Geophysical and Geotechnical and Surveys in the Alaskan Chukchi and Beaufort Seas in 2013

Shell Gulf of Mexico Inc.
and
Shell Offshore Inc.

December 2012

TABLE OF CONTENTS

Introduction

Shell plans to conduct a marine mammal monitoring and mitigation program (4MP) for their geophysical and geotechnical surveys in the Chukchi and Beaufort Seas during the 2013 open-water season. These geophysical and geotechnical surveys are designed to gather data on seafloor soil properties, and ice gouge in select areas of the Beaufort and Chukchi Seas. These surveys and investigations are continuations of similar data acquisition programs conducted by Shell in the Beaufort Sea beginning in 2006, and in the Chukchi Sea in 2008, with the addition of the geotechnical investigations.

Ice gouge surveys investigate the depth and distribution of ice gouges into the seabed and geotechnical surveys are used to characterize the seabed (seafloor and shallow sub-seafloor sediments) within select areas of interest near offshore drilling locations and potential pipeline corridors. The types of equipment used to conduct these surveys are focused on limited areas and emit low-level, very-high to low frequency acoustic impulse sounds or low-level, low frequency continuous sounds during discrete time periods over very limited areas of the ocean bottom and intervening water column.

Geophysical surveys are planned along ~400 km of trackline in the Chukchi Sea and along ~1000 km of trackline in the Beaufort Sea. Geotechnical surveys will include 28 boreholes in the Chukchi Sea and seven boreholes in the Beaufort Sea. Each borehole will be 40-50 ft deep.

Geophysical equipment to be used includes:

- Single-beam Echo Sounder, or similar;
- Dual-frequency side scan sonar, or similar;
- Multibeam Echo Sounder, or similar;
- 3.5 kHz Shallow Sub-bottom Profiler, or similar, CHIRP only
- Magnetometer
- Ultra Short Baseline Positioning System (USBL) or similar

Boreholes will be excavated using a Jumbo Piston Core/Stinger CPT system made by TDI-Brooks or a PROD or similar remote drilling platform. Either of these systems would be used while the ship was in dynamic positioning (DP) mode.

Shell plans to conduct the geophysical and geotechnical surveys with one vessel. Timing of the work will depend on weather, ice conditions, and avoidance of subsistence activities. The surveys are planned to occur from July through October. The broad timeframe is required because surveys need to occur at specific sites and it is not possible to know precise dates that the sites will be accessible. Work would begin in July in accessible areas of the Chukchi Sea. The vessel would move into the Beaufort Sea to complete work there as the ice cleared during summer. Following completion of work in the Beaufort Sea the vessel would return to the Chukchi Sea and complete any remaining work.

The 4MP developed for Shell's planned activities supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE), the National Marine Fisheries Service (NMFS), and the

U.S. Fish and Wildlife Service (USFWS), and establishes a means for gathering additional data on marine mammals for future operations planning.

Marine Mammal Monitoring

Shell's 4MP is a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimize project impacts to marine resources. Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished by conducting vessel-based monitoring from all ships with sound sources (at a minimum), manned aerial surveys, aerial photographic surveys, and acoustic monitoring programs to document the potential reactions of marine mammals in the area to the various sounds and activities. Shell's geophysical and geotechnical surveys will operate concurrently with exploratory drilling programs in both the Beaufort and Chukchi Seas. Large-scale, wide-area marine mammal monitoring planned as part of the exploratory drilling operations will provide detailed information on the movement of marine mammals in and through the area of operations and their reactions to Shell's activities. Similar to other programs, Shell will characterize the sounds produced by the geotechnical investigation activities and will monitor marine mammals from the survey vessel to provide information on impacts that may be specific to these operations.

Visual monitoring by Protected Species Observers (PSOs) during geotechnical activities, and periods when these surveys are not active, will provide information on the numbers of marine mammals potentially affected by the survey activities and facilitate real time mitigation to prevent impacts to marine mammals by industrial sounds or activities. Vessel-based PSOs onboard the survey vessel will record the numbers and species of marine mammals observed in the area and any observable reaction of marine mammals to the survey activities. Acoustic measurements will be made to establish safety radii for real time mitigation around the soil coring operations should it be necessary, and to verify pre-season estimates of the sound footprints for activities. Preliminary sound source analyses for the coring equipment and vessel will be supplied to NMFS within 120 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90-day report following the end of the season.

An aerial photographic survey around the offshore drilling operations, manned aerial surveys to monitor marine mammals in coastal and nearshore areas of the Chukchi Sea, and recordings of ambient sound levels and vocalizations of marine mammals along the Chukchi Sea coast and offshore will also be used to interpret potential impacts to marine mammals around the offshore exploration drilling operations, in areas where geotechnical and geophysical surveys are conducted, and in subsistence use areas closer to shore. While these monitoring programs were designed primarily to understand the impacts of exploratory drilling in the Chukchi Sea they will also provide valuable information about the potential impacts of the geotechnical surveys on marine mammals in the area.

Similarly, monitoring in the Beaufort Sea will include aerial surveys, designed primarily for detecting cetaceans, to identify any large scale distributional changes of cetaceans relative to Shell's activities and will add to the existing database on the abundance and distribution of observed species. An addition to the aerial monitoring in 2012 and 2013 is the capture of digital still and video imagery at the same time as the aerial surveys. This imagery will be collected with sensors that will be deployed in unmanned aerial systems (UAS) in the future and the data will be used to validate and compare observations made by

people with those obtainable in the imagery. The acoustic program will characterize the sounds produced by the exploration drilling activities and support vessels, as well as the geophysical and geotechnical surveys, and will document the potential reactions of marine mammals in the area, particularly bowhead whales, to those sounds and activities.

Vessel-Based Marine Mammal Monitoring Program

Introduction

The vessel-based operations of Shell's 4MP are designed to meet the requirements of Incidental Harassment Authorization (IHA) and Letter of Authorization (LOA) permits issued by NMFS and USFWS, respectively, and to meet any other stipulation agreements between Shell and other agencies or groups. The objectives of the program will be:

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

The 4MP will be implemented by a team of experienced PSOs, including both biologists and Inupiat personnel. PSOs will be stationed aboard the geophysical and geotechnical survey vessel through the duration of the project. Reporting of the results of the vessel-based monitoring program will include the estimation of the number of "takes" as stipulated in the IHA and LOA.

The vessel-based portion of Shell's 4MP will be required to support the survey activities in the Chukchi and Beaufort Seas. The survey dates and specific operating areas are described above, but will also depend somewhat upon ice and weather conditions.

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 "takes" of marine mammals by harassment, which must be reported to NMFS and USFWS,
- data on the occurrence, distribution, and activities of marine mammals in the areas where the survey program is conducted,
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the survey vessel at times with and without various activities, and
- a communication channel to coastal communities including Inupiat whalers and other subsistence users.

The 4MP will be operated and administered consistent with monitoring programs conducted during seismic and shallow hazards surveys, geotechnical coring operations, and exploratory drilling in 2006–2012 or such alternative requirements as may be specified in the authorizations issued this project. Any other stipulations from agreements between Shell and agencies or groups such as BOEM, BSEE, USFWS, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) will

also be fully incorporated. All PSOs will be provided training through a program approved by NMFS and Shell, as described below. At least one observer on each vessel will be an Inupiat who will have the additional responsibility of communicating with coastal communities and directly with Inupiat whalers during the whaling season.

Mitigation Measures during Survey Activities

Shell's planned geophysical and geotechnical surveys incorporate both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures have been described in the IHA and LOA applications submitted to NMFS and USFWS, respectively and are summarized below. Survey design features include:

- timing and locating survey activities to avoid interference with the annual spring beluga hunt at Point Lay and the fall bowhead whale hunt;
- identifying transit routes and timing to avoid other subsistence use areas and communicate with coastal communities before operating in or passing through these areas, and;
- limiting the size of the sound sources to minimize energy introduced into the marine environment;
- establishing precautionary safety radii based on previous measurements of a similar sound source in the area for implementation prior to completion of sound source measurements in 2013.

The potential disturbance of marine mammals during survey operations will be minimized further through the implementation of several ship-based mitigation measures if mitigation becomes necessary.

Safety and Disturbance Zones

Under current NMFS guidelines (e.g., NMFS 2000), "safety radii" for marine mammals around industrial sound sources are customarily defined as the distances within which received sound levels are ≥180 dB re 1 μPa (rms) for cetaceans and ≥190 dB re 1 μPa (rms) for pinnipeds. These safety criteria are based on an assumption that sound energy received at lower received levels will not injure these animals or impair their hearing abilities, but that higher received levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson et al. 1995).

Shell plans to use one, dedicated vessel to conduct both the geophysical and geotechnical surveys. The ship will probably be similar to the *Nordica* used by Shell in 2012. Preliminary sound measurements of the *Nordica* during operations in 2012 indicated a 120 dB sound radius of ~4 km. Sounds produced by the soil coring equipment are not expected to exceed the sound signature of the ship during active DP. Therefore, mitigation related to acoustic impacts from these activities are not expected to be necessary.

Sounds produced by the other equipment that Shell plans to use for these studies has been measured (JASCO Applied Sciences 2010, Hartin et al. 2011) and is not expected to produce enough sound within relevant frequencies to have more than negligible impacts on marine mammals in the immediate area of the surveys.

An acoustics contractor will perform direct measurements of the received levels of underwater sound versus distance and direction for each vessel and from the geotechnical survey vessel during active coring operations using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably

practicable in the field and used to verify and adjust the safety distances. The field report will be made available to NMFS and the PSOs within 120 hrs of completing the measurements.

Protected Species Observers

Vessel-based monitoring for marine mammals will be done by trained PSOs throughout the period of survey activities to comply with expected provisions in the IHA and LOA that Shell receives. The observers will monitor the occurrence and behavior of marine mammals near the survey vessel during all daylight periods during operation, and during most daylight periods when operations are not occurring. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting "take by harassment" as defined by NMFS.

Number of Observers

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

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

PSO teams will consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the PSO team onboard the survey vessel. The total number of PSOs may decrease later in the season as the duration of daylight decreases assuming NMFS does not require continuous nighttime monitoring. Shell currently plans to have 4 PSOs aboard the survey vessel.

Crew Rotation

Depending on the duration of the activities, Shell may conduct crew changes during the season. During crew rotations detailed hand-over notes will be provided to the incoming crew leader by the outgoing 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 possible. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

Observer Qualifications and Training

Crew leaders and most other biologists serving as observers in 2013 will be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring and mitigation projects. Resumés for those individuals will be provided to NMFS for review and acceptance of their qualifications. Inupiat observers will be experienced in the region and familiar with the marine mammals of the area. All observers will complete a NMFS approved observer training course designed to familiarize individuals with monitoring and data collection procedures. A marine mammal observers' handbook, adapted for the specifics of the planned survey program will be prepared and distributed beforehand to all PSOs (see below).

Observers will complete a two or three-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2013 open-water season. Any exceptions will

have or receive equivalent experience or training. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- review of the marine mammal monitoring plan for this project, including any amendments specified by NMFS or USFWS in the IHA or LOA, by BOEM, BSSE or by other agreements in which Shell may elect to participate;
- review of marine mammal sighting, identification, and distance estimation methods;
- review of operation of specialized equipment (reticle binoculars, night vision devices, and GPS system);
- review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on marine mammal sightings, monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers;
- review of the specific tasks of the Inupiat Communicator.

PSO Handbook

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

- summary overview descriptions of the project, marine mammals and underwater noise, the marine mammal monitoring program (vessel roles, responsibilities), the NMFS IHA and USFWS LOA and other regulations/permits/agencies, the Marine Mammal Protection Act;
- monitoring and mitigation objectives and procedures, initial safety radii;
- responsibilities of staff and crew regarding the marine mammal monitoring plan;
- instructions for ship crew regarding the marine mammal monitoring plan;
- data recording procedures: codes and coding instructions, PSO coding mistakes, electronic database; navigational, marine physical, field data sheet;
- list of species that might be encountered: identification, natural history;
- use of specialized field equipment (reticle binoculars, NVDs, laser rangefinders);
- reticle binocular distance scale;
- table of wind speed, Beaufort wind force, and sea state codes;
- data storage and backup procedures;
- safety precautions while onboard;
- crew and/or personnel discord; conflict resolution among PSOs and crew;
- drug and alcohol policy and testing;
- scheduling of cruises and watches;

- communications;
- list of field gear that will be provided;
- suggested list of personal items to pack;
- suggested literature, or literature cited; and
- copies of the NMFS IHA and USFWS LOA when available.

Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge. The observer(s) will scan systematically with the unaided eye and 7×50 reticle binoculars, supplemented with 20×60 image-stabilized Zeiss Binoculars, and night-vision equipment when needed. Personnel on the bridge will assist the marine mammal observer(s) in watching for marine mammals.

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

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

The ship's position, speed of the vessel, water depth, sea state, ice cover, visibility, 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 substantial change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7×50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience has shown that a Class 1 eye-safe device was not able to measure distances to seals more than about 70 m (230 ft) away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 600 m (1968 ft)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20% when given immediate feedback about actual distances during training.

When a marine mammal is seen within the safety radius applicable to that species, the geophysical crew will be notified immediately so that mitigation measures called for in the applicable authorization(s) can be implemented.

Monitoring At Night and In Poor Visibility

Night-vision equipment (Generation 3 binocular image intensifiers, or equivalent units) will be available for use when/if needed. Past experience with night-vision devices (NVDs) in the Beaufort and Chukchi seas and elsewhere has indicated that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Field Equipment

Shell will provide or arrange for the following specialized field equipment for use by PSOs aboard the survey vessel: reticle binoculars, 20×60 image-stabilized Zeiss Binoculars, GPS unit, laptop computer(s), night vision binoculars, digital still and possibly digital video cameras.

Field Data-Recording, Verification, Handling, and Security

The observers will record their observations onto datasheets or directly into computers running a custom designed software package. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be sent off of the ship to Anchorage each day (if possible) and backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

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

Field Reports

Throughout the survey program, observers will prepare a report each day or at such other intervals as NMFS, USFWS, BOEM, BSEE or Shell may require, 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 and to the survey operators.

Reporting

The results of the 2013 vessel-based monitoring, including estimates of "take by harassment", will be presented in 90-day and final technical reports. Reporting will address the requirements established by NMFS and USFWS.

The technical report(s) will include:

- summaries of monitoring effort: total hours, total distances, and distribution of marine mammals through the study period accounting for sea state and other factors affecting visibility and detectability of marine mammals;
- analyses of the effects of various factors influencing detectability of marine mammals including sea state, number of observers, and fog/glare;
- species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover;
- analyses of the effects of survey operations:
    - sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
    - initial sighting distances versus airgun activity state;
    - closest point of approach versus airgun activity state;
    - observed behaviors and types of movements versus airgun activity state;
    - numbers of sightings/individuals seen versus airgun activity state;
    - distribution around the survey vessel versus airgun activity state;
    - estimates of "take by harassment."

Acoustic Monitoring Plan

Sound Source Measurements

As described above, Shell plans to use a dedicated vessel similar to the *Nordica*, used in 2012, to conduct the proposed geophysical and geotechnical surveys. Based on preliminary measurements the 120 dB (rms) isopleth is expected to be ~ 4 km from the ship during coring activities and during active DP.

Sounds produced by the other equipment that Shell plans to use for these studies have been measured (JASCO Applied Sciences 2010, Hartin et al. 2011) and are not expected to be great enough to have more than negligible impacts on marine mammals in the immediate area of the surveys.

Shell will conduct sound source characterizations on the survey vessel, during active coring, and while in DP without coring in the areas of operation in the Chukchi and Beaufort Seas. If Shell uses the seabed drilling and piston coring system we are not aware of any measurements of this type of system in the Chukchi or Beaufort Sea though we anticipate similar or lower sound levels to those described earlier for coring work based upon manufacturer specifications for the system.

The objectives of the sound source verification measurements planned for 2013 will be (1) to measure the distances at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 μPa (rsm) for the coring equipment and vessels that may be used during the survey activities. The measurements will be made by an acoustics contractor at the beginning of the surveys. The distances to the various radii will be reported as soon as possible after recovery of the recording equipment.

Data will be previewed in the field immediately after download from the hydrophone instruments. An initial sound source analysis will be supplied to NMFS and the vessel within 120 hours of completion of the measurements, if possible. The report will indicate the distances to sound levels based on fits of

empirical transmission loss formulae to data in the endfire and broadside directions. A more detailed report will be issued to NMFS as part of the 90-day report following completion of the acoustic program.

Acoustic "Net" Array in Chukchi Sea

Background and Objectives

This section describes acoustic studies that were undertaken from 2006 through 2012 in the Chukchi Sea as part of the Joint Monitoring Program that will be continued by Shell during exploration drilling and geophysical and geotechnical survey operations in 2013. The acoustic "net" array used during the 2006–2012 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 located on 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.

Technical Approach

A net array configuration similar to that deployed in 2007–2012 is again proposed for 2013. The basic components of this effort consist of autonomous acoustic recorders deployed widely across the US Chukchi Sea through the open water season and then winter season. These precisely calibrated systems will 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 24 Autonomous Multichannel Acoustic Recorders (AMAR) deployed July-October off the four main transect locations: Cape Lisburne, Point Hope, Wainwright and Barrow as shown in Figure 1. These will be augmented by six AMARs deployed August 2013 – August 2014 at Hanna Shoal. Six additional AMAR recorders will be deployed in a hexagonal geometry at 16 km from the nominal drillship location to monitor directional variations of drilling-related sounds and to examine marine mammal vocalization patterns in vicinity of exploration drilling activities. One new recorder will be placed 32 km northwest of the drillship to monitor for drilling sound propagation toward the south side of Hanna Shoal, which acoustic and satellite tag monitoring has identified as frequented by walrus in August. Geophysical and geotechnical survey activities will occur in areas within the coverage of the net array, though no recorders will specifically be placed near the coring operations. All of these offshore systems will capture exploration drilling sounds, and geophysical and/or geotechnical survey sounds, where present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. They will continue to provide a large amount of information related to marine mammal distributions in the Chukchi Sea.

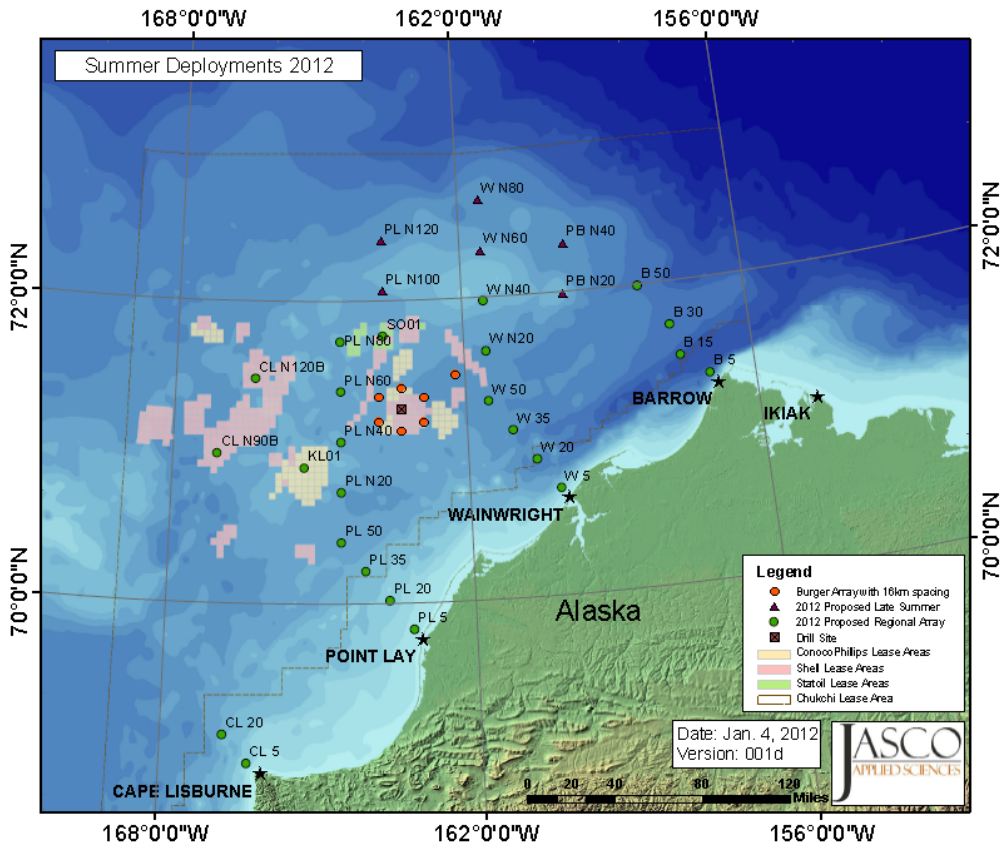


Figure 1. Proposed open water deployment locations of acoustic recorders in the eastern Chukchi Sea, Alaska 2013.

In early October, all of the regional recorders will be retrieved except for the six Hanna Shoal recorders, which will continue to record on a duty cycle until August 2014. An additional set of nine Aural winter recorders will be deployed at the same time at the same locations that were instrumented in winter 2012 - 2013 (Figure 2). These 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 bowhead, beluga, walrus and several seal species migrations in fall and spring.

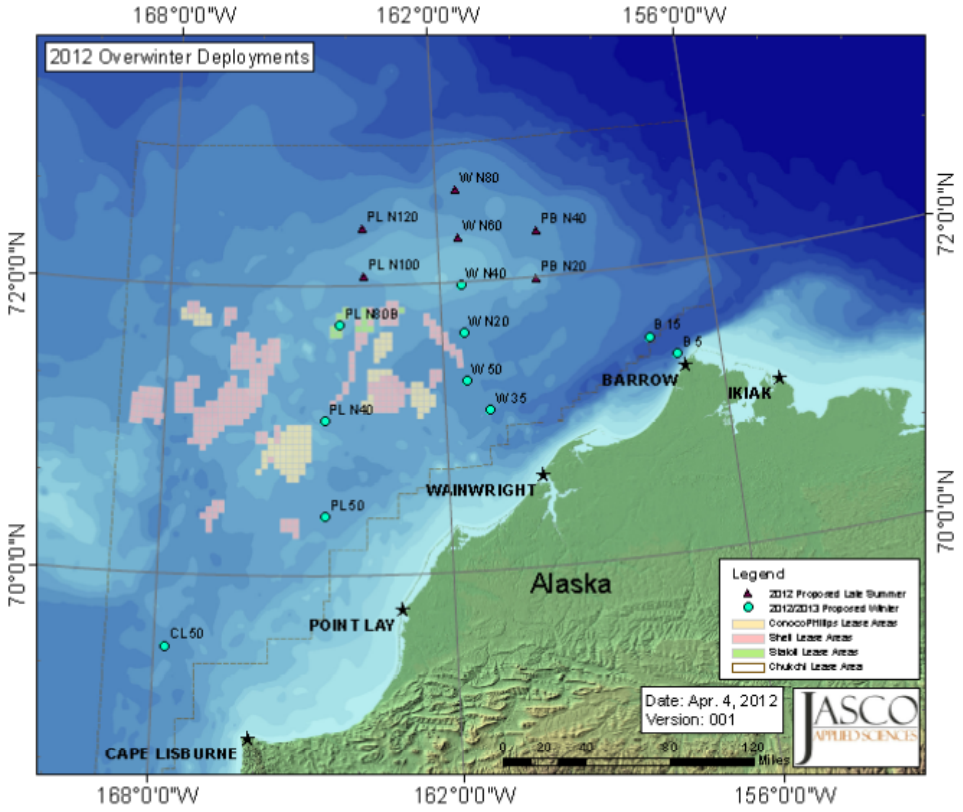


Figure 2. Proposed winter deployment locations of acoustic recorders in the eastern Chukchi Sea, Alaska 2013. The Hanna Shoal recorders (triangles) are deployed in August. The winter recorders (dots) are deployed in early October.

Analysis and Reporting

The Chukchi acoustic net arrays 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 sound propagation from Shell's exploration drilling and other activities over a very large area. It is expected that sounds from drilling activities will be detectable on hydrophone systems within approximately 30 km of the drillship when ambient sound energy conditions are low. The drilling sound levels at recorder locations will be quantified and reported. Similarly, sounds from the geotechnical surveys that are detectable 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 drillship activities, as well as sounds from the geophysical and geotechnical surveys. 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, coring and other activities, or vessel sound levels).

Acoustic Study of Bowhead Call Distributions

Shell plans to deploy arrays of acoustic recorders in the Beaufort Sea in 2013, similar to that which was done in 2007–2012. As in previous years, the recorders (DASARs, or directional autonomous seafloor acoustic recorders) will be supplied by Greeneridge Sciences. These directional acoustic systems permit localization of bowhead whale and other marine mammal vocalizations. The purpose of the array will be to further understand, define, and document sound characteristics and propagation resulting from vessel-based exploration drilling operations that may have the potential to cause changes in the distribution of bowhead whales—as witnessed by their calls—within their migration pathway. Of particular interest will be the east-west changes in call distribution, if any. In other words, how far east or west of a sound source can changes in the distribution of calls be detected? Similarly, will the presence of a sound source result in a shift of calling whales offshore or toward shore?

In previous work around seismic and drillship operations in the Alaskan Beaufort Sea, the primary method for studying this question has been aerial surveys. Acoustic localization methods will provide supplementary information for addressing the question of the effects of industrial activities on bowhead whale distribution. Compared to aerial surveys, acoustic methods have the advantage of providing a vastly larger number of call detections, and can operate day or night, independent of visibility, and to some degree independent of ice conditions and sea state—all of which prevent or impair aerial surveys. However, acoustic methods depend on the animals to call, and to some extent assume that calling rate is unaffected by exposure to industrial noise. Bowheads call frequently in fall, but there is evidence that their calling is reduced upon exposure to airgun pulses, complicating interpretation. The combined use of acoustic and aerial survey methods will provide a suite of information that should be useful in assessing the potential effects of exploration drilling and geophysical and geotechnical survey operations on migrating bowhead whales.

Objective

The objectives of this study are (1) to provide information on bowhead migration paths along the Alaskan coast, particularly with respect to industrial operations, and to determine whether and to what extent there are changes in the distribution of calls due to industrial sound levels; and (2) to provide information on the broadband sound levels produced by the *Kulluk* and geotechnical survey coring operations, their frequency composition, and how they decrease with distance from the source. Using passive acoustics with directional autonomous recorders, the locations of calling whales will be observed for a six- to ten-week continuous monitoring period at five coastal sites (subject to favorable ice and weather conditions). An example of the whale call locations measured from a similar array of DASARs in 2008 is presented in Figure 3 (Blackwell et al. 2010). Concurrently, continuous measurements of sound levels near and at increasing distances from the drillship will be obtained. While these studies were developed primarily to understand the reaction of bowhead whales to exploratory drilling operations, they will also collect data

that will be useful in understanding the impacts of the geophysical and geotechnical surveys on the movements of bowheads through the Beaufort Sea.

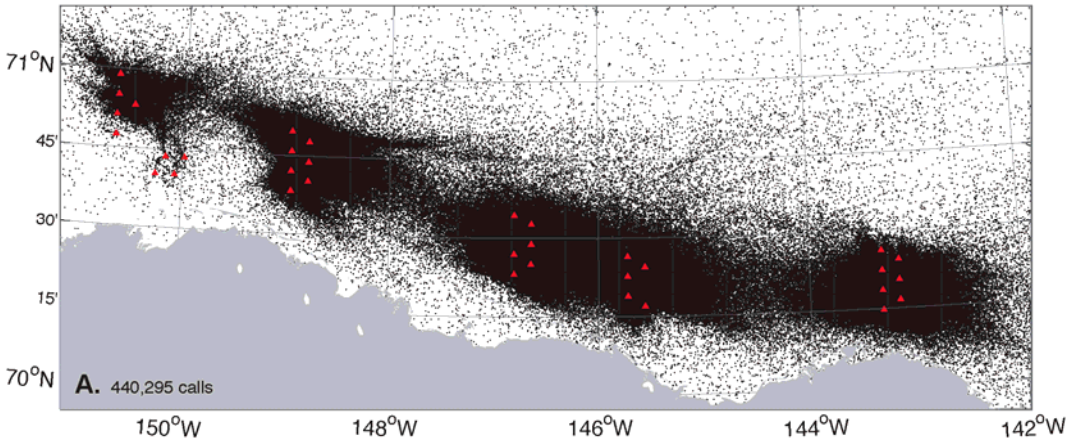


Figure 3. Bowhead whale call locations determined from the received bearings at five arrays of DASARs in the Beaufort Sea in 2008.

Monitoring Plan

Shell plans to conduct the whale migration monitoring using the passive acoustics techniques developed and used successfully since 2001 for monitoring the migration past the Northstar production island northwest of Prudhoe Bay and from Kaktovik to Harrison Bay during the 2007 through 2012 migrations. Those techniques involved using DASARs to measure the bearings to bowhead calls and, when two or more recorders detected the same call, obtaining the calling whale's location by triangulation. A total of about a million whale calls were successfully located during the years 2007–2011.

In attempting to assess the responses of bowhead whales to the planned industrial operations, it will be essential to monitor whale locations at sites both near and far from industry activities. Shell plans to monitor at five sites along the Alaskan Beaufort coast, as shown in Figure 4. The sites are the same as used since 2007, but the layout of the DASAR recorders will be somewhat different from previous years, in order to improve our ability to detect calls during the drilling operations. The eastern-most site (site 5 in Figure 4 is just east of Kaktovik ~62 mi [~100 km] west of the Sivulliq drilling area) and the western-most site (site 1) is in the vicinity of Harrison Bay (~112 mi [~180 km] west of Sivulliq). Site 2 is located west of Prudhoe Bay (~73 mi [~117 km] west of Sivulliq). Site 4 is ~10 mi (~16 km) east of the Sivulliq drilling area and site 3 is ~20 mi (~32 km) west of Sivulliq.

The proposed geometry of the DASAR array at each site is shown in Figure 4, while Figure 5 zooms in on the two sites (3 and 4) adjacent to the Sivulliq and Torpedo prospects. In 2007–2011 each array was comprised of seven DASARs placed at the vertices of five stacked equilateral triangles with 7-km (4.3-mi) sides, as exemplified by sites 2, 3, or 5 in Figure 4 DASARs were labelled A–G from south to north. In 2012 the following changes were made in the DASAR layout of sites 1 and 4 and these same recorder locations will also be used in 2013. Placement of DASARs, as explained above, is optimized for exploratory drilling monitoring but will also provide useful data for monitoring the contribution of geophysical and geotechnical surveys to sound levels in the Beaufort Sea and the potential impacts of those sounds on bowhead whales.

- At site 1 the three adjacent DASARs that have detected the most calls in 2007–2011 (1D, 1E, and 1F) will be kept in place, to continue collecting data that can be compared with previous years. The remaining four DASARs (1A, 1B, 1C, and 1G) will be moved to site 4 (see below). These four low-performance DASAR locations have, on average (2007–2011), detected as little as 1/100th of the calls detected at high-performance locations.
- At site 4 the four central DASARs (4A, 4C, 4E, and 4G) will be moved to their mirror-image position east of DASARs 4B, 4D, and 4F. This is shown in Figures 4 and 5. The main reason for doing this is to improve our ability to detect whale calls by placing these DASARs farther away from the drilling operation, where background sound levels will likely be lower. The four DASARs removed from site 1 will be added to the northern end of site 4 (4J, 4K, 4L, and 4M in Figure 5). This will improve the detection of calls from whales that choose a more northern route while migrating westward past the drilling operation.

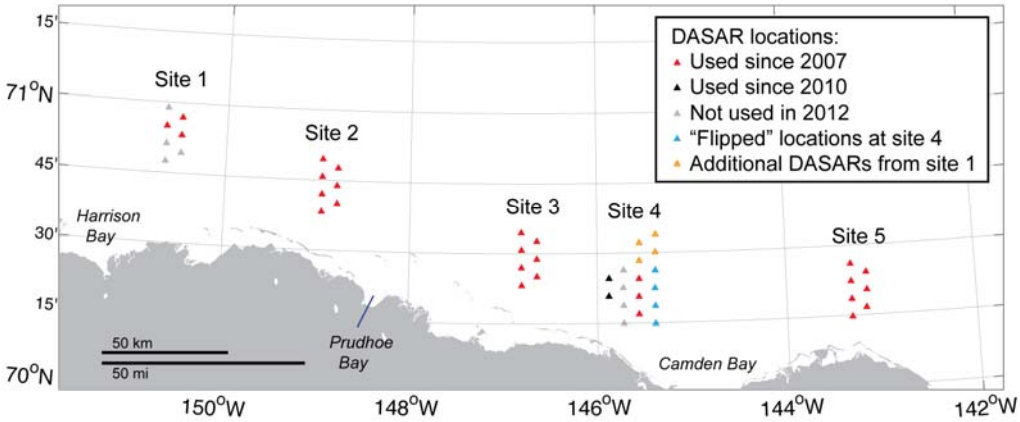


Figure 4. The Alaskan Beaufort Sea coast showing the five DASAR arrays (sites 1–5) for whale call location studies. DASAR deployments in 2013 are planned for all but the gray locations. See text for more information.

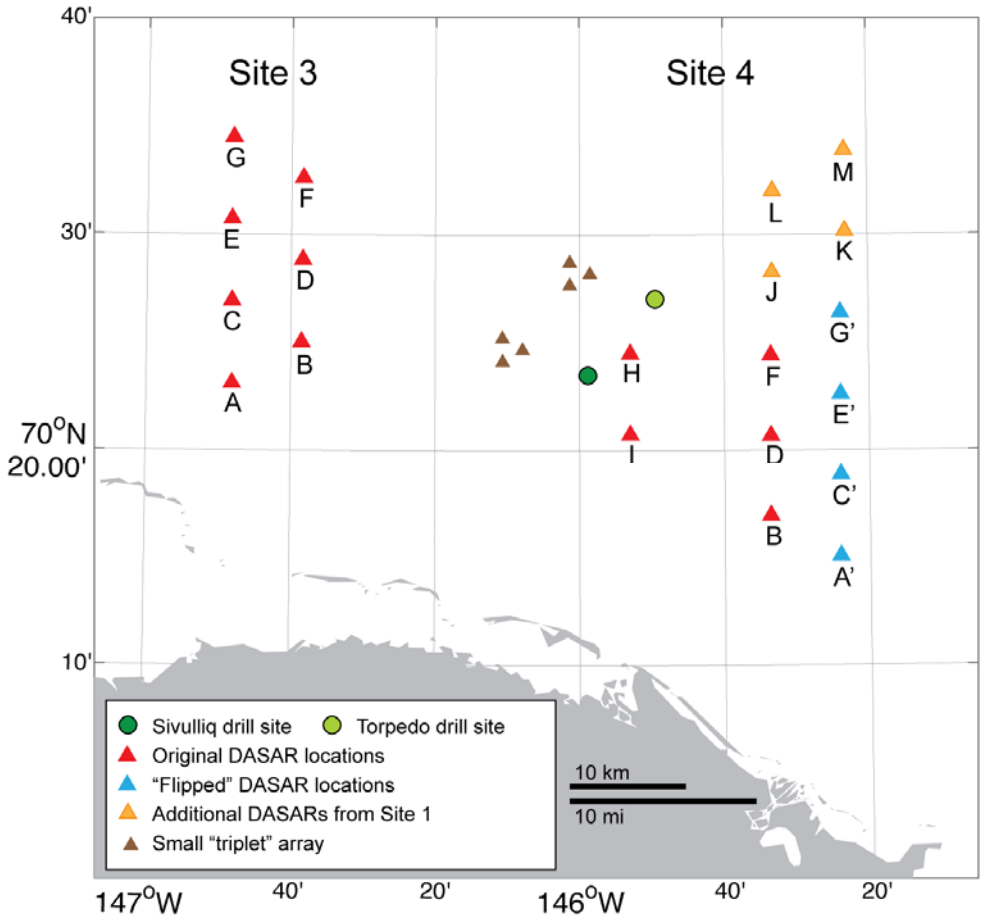


Figure 5. DASAR deployments at sites 3 and 4. DASARs are shown with triangles and the two drill sites, Sivulliq and Torpedo, are shown with green dots. The drill sites will be used consecutively. The triplets of DASARs (small brown triangles) will be retrieved when and if the drillship is moved and redeployed in the new location in the same relative positions. All other DASARs will remain in place over the entire season.

In addition, a small array of three DASARs with 2 km spacing—referred to as a triplet—will be deployed northwest of each drillsite, with the closest DASAR 6 km from the drillship. When and if the drillship is moved to another site, the triplet of DASARs will be retrieved and redeployed in the same relative locations. The triplets are shown in Figure 5 as small brown triangles.

DASARs will be installed at planned locations using a GPS. However, each DASAR's orientation, once deployed on the bottom, is unknown and must be determined to know how to reference the bearings measured to the whales. That is, where is true north relative to the DASAR orientation? Also, the internal clocks used to sample the acoustic data typically drift slightly, but linearly, by an amount of up to about three minutes after six weeks of autonomous operation. Synchronizing DASARs to within a second is essential for identifying identical whale calls received on two or more DASARs. Solving these two problems is accomplished by transmitting known sounds at known times from known locations (by GPS) at three points around each DASAR at the beginning and at the end of the operational period. Each set of transmissions requires about two minutes. With 12 calibration locations for a 7-DASAR array, calibration of a "standard" site will take 4 hrs. Calibration of site 4 will take longer, on the order of ~12 hours in good weather.

The calibration transmissions are made using a J9 projector easily deployed and retrieved over the side of a vessel by a single person. Maximum source level is 150 dB re 1 µPa at 1 m. The received level at a distance of 328 ft (100 m) will be ~110 dB, a level less than any known to cause disturbance to marine life.

Bowhead migration begins in late August with the whales moving westward from their feeding sites in the Canadian Beaufort Sea. It continues through September and well into October. We are planning to deploy the DASAR arrays in early to mid July 2013 and retrieve them in early October, before they become inaccessible because of ice.

Whale call analysis will be done using an automated algorithm developed by Dr. Aaron Thode at Scripps Institution of Oceanography and described in Thode et al. (in press). Concurrently, about 10% of the collected data will also be analyzed manually, to provide a dataset with which to train the automated algorithm and then check its performance. During the manual analysis analysts will examine spectrograms in one-minute periods, looking for patterns identifying a whale call. The analyst will then confirm that a sound is indeed a whale call by listening to it. The call's bearing is then calculated and stored for localization if the same call is detected by other DASARs in the array being analyzed.

The distributions of bowhead calls will be analyzed in relation to the presence of industrial activities, and the amplitude of the sounds produced by these activities. Received levels of sound at DASARs will be matched with the number of calls detected at each DASAR. This will provide information on whether certain received levels of sounds, i.e., a certain "dose" of sound, result in whales stopping to call, as seen with airgun pulses (Blackwell et al., in preparation). Call numbers at each DASAR will also be compared to the call numbers obtained in previous years at the same locations, to see whether call distributions in 2013 differ from previous years. The distribution and density of bowhead calls will be assessed as a function of activities at the drill rig and the movements and activities of vessels including the geophysical and geotechnical survey vessel.

DASAR records will also be analyzed for broadband background levels and the frequency composition of the recorded sounds will be determined. In addition to being influenced by anthropogenic activities, background levels are tightly linked to sea state. Therefore, even in the complete absence of anthropogenic sound sources, background sound levels show substantial variation over time. For each DASAR, narrowband spectral densities (1 Hz intervals, 1.7 Hz bandwidth, 23.5% overlap) will be determined for a one-min period about every 5 min. One-third octave band and broadband levels will be derived from the narrowband spectral densities. These narrowband, one-third octave, and broadband data will provide a continuous record, with 1 min resolution, of the levels of low-frequency underwater sounds at each location.

The narrowband data will also be summarized over periods of interest to derive "statistical spectra" showing, for each frequency, the levels exceeded during various percentages of the 1-min samples. This type of analysis is useful for describing the frequency composition of sounds received at a particular location over long periods of time (like the entire deployment of the recorder) or, alternatively, during particular shorter-term events.

Received levels of sound at DASARs at various distances from the drillship will be used to describe how sounds from the drilling operation—the drillship and attending vessels—decrease as a function of distance. For example, for the Sivulliq prospect DASARs at sites 3 and 4 will be deployed at approximate distances of 4, 6, 6.5, 7.5, 8, 16, 17, 18, 20, 22, 22.5 (twice), 23.5, 25, 25.5, 26.5, 27, 29, 30,

31, 32, 34, and 37 km from the drillship, in many different directions (see Figure 9). This information will be used to create 3-D maps of received levels of sound as a function of the activities at the drill site.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions are to (a) determine when and where bowhead whales are acoustically detected on each DASAR, (b) analyze data as a whole to determine the distribution of bowhead calls as a function of time and industrial activities, (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).

Aerial Monitoring Plan

The aerial monitoring program described here was designed to collect data primarily to understand the potential impacts of the Shell drilling programs in the Chukchi and Beaufort Seas in 2013. The limited duration and sound footprint of the proposed geophysical and geotechnical surveys would typically not include aerial surveys as part of the monitoring requirements. Surveys planned as part of the drilling monitoring program will, however provide information that will help to characterize the effects of the geophysical and geotechnical surveys on marine mammals in the area.

2013 Chukchi Offshore Aerial Photographic Monitoring Program

Shell has been reticent to conduct manned surveys in the offshore Chukchi Sea because conducting those surveys on a regular basis puts people at risk. There is a strong desire; however, to obtain data on marine mammal distribution in the offshore Chukchi Sea and Shell will conduct a photographic aerial survey in 2013 that would put fewer people at risk as an alternative to the 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. Currently UAS are not authorized to fly in civilian airspace in the US except under very restricted conditions but legislation is in place to permit use of UAS by mid-2013. The proposed photographic surveys in the Chukchi and Beaufort Seas would collect data that will allow direct comparisons of photographic techniques for data collection with data collected by human observers aboard the aircraft. The aerial survey program in the Beaufort Sea will provide side-by-side comparisons of data collected by PSOs on the survey aircraft with digital imagery collected at the same time by still and video cameras. Surveys in the Chukchi Sea will use only digital cameras when flying offshore, but will have observers and digital data collection when the nearshore and coastline surveys are conducted. Data from surveys that use both observers and cameras will permit direct comparisons to evaluate the efficacy of the digital platform in comparison to observer collected data and development of correction factors to account for any differences between data that can be collected by PSOs and digital 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. For example, Koski and Davis (1980), Koski et al. (2002) and Richard et al. (1990) used aerial photography to provide more precise estimates of numbers of belugas in

concentration areas during aerial surveys of Lancaster Sound and Hudson Bay, respectively. Later Richard et al. (1994), Witting et al. (2005) and Heide-Jørgensen et al. (2010) used aerial photography to estimate numbers and densities of narwhals and minke whales in their survey 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, to the point that observations at the outer limits of the transect decline to 5-10% of the animals present. 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.

In the past, the major impediment to use of aerial photography for some studies has been the resolution of the cameras and the resulting area that can be captured on film or digital media; that is, the area recorded by a single camera was too narrow to provide sufficient sightings for meaningful analyses. Current 35 mm cameras have more pixels (5,616 pixels in horizontal resolution), and hence higher resolution, than the 70 mm cameras used during the studies described above (2,656 pixels horizontal resolution) and numbers of sightings that will be captured on film or digitally will likely match or exceed the numbers captured by humans surveying in an aircraft using current camera technologies.

During the 2012 field season Shell successfully conducted photographic surveys using two Nikon D800 cameras mounted in a Twin Otter to record marine mammals around their drill sites in the Chukchi Sea. In addition, a HD video camera was tested and is being compared to the still camera for evaluation as a tool for real-time monitoring during future studies. A similar approach is planned for 2013. The photographic survey provides 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. Comparisons are currently being made between data collected by human observers on board both the Chukchi and Beaufort aerial survey aircraft and the digital imagery collected in 2012. The 2013 surveys would add to this data set and increase our understanding of how these data compare to traditional aerial survey data.

Camera Specifications

The cameras that we will use are Nikon D800s, which are 36.3 megapixel cameras that store imagery in 7,360×4,912 pixel arrays. The cameras will be triggered every four seconds providing 50% overlap with adjacent photos and 100% overlap among all imagery. The cameras will have 20 mm lenses, which will each cover a swath ~753 m on the water surface with one pixel representing a 10.2 cm square at the water surface at an altitude of 1000 feet. This pixel size is one quarter of the pixel size (25 cm square) tested by Koski et al. (2009) during their tests with a video camera for detection of kayaks and is a smaller pixel size (better resolution) than was tested by Amanda Hodgson (16.8 cm^2) during her surveys of humpback whales off Australia and which proved adequate for counting humpback whales in their imagery. It is expected that this resolution will permit identification of all medium and large cetaceans and counting of small cetaceans, except for perhaps harbor porpoises, and will permit counting of walrus/bearded seals. It

may not permit differentiation of bearded seals from walrus, especially when they are in the water. This imagery resolution provides slightly better ability for determining species and detecting animals than people would have in an aircraft flying at 1,000 feet above sea level.

Two options are available for operation of the two cameras and the option that will be used depends on monitoring requirements for walrus. One option has one camera with the 20 mm lens pointed vertically and covering a 753 m swath and a second camera with a 100 mm lens pointed vertically covering a 144 m swath. This option provides the ability to detect marine mammals too small to reliably detected and identified during manned surveys such as ringed, spotted and ribbon seals and harbor porpoise and to classify animals such as walrus to age/sex categories that could not be identified during manned surveys; it also permits us to accurately count walruses hauled out on ice. The longer lens would also permit accurate classification of bearded seals and female walrus which cannot be done during manned surveys in most situations. Figure 6 shows imagery taken during resolution tests by Shell at Camp Roberts, California, in December 2009. This is an example of imagery that can be obtained with a resolution of 3 cm at the water surface, which is similar to, but slightly poorer than, the 2.4 cm resolution that we propose for the camera with a 100 mm lens. A ringed seal would be about the width of the second largest square in the bottom left photograph (40 cm) and about 3 times longer.

Figure 6. Photograph taken from an UAS during resolution tests at Camp Roberts, California, during December 2009. The upper photographs were taken with a 12 megapixel camera with resolution on the ground of 2.9 cm. The colored patches in the lower left photograph vary in size from 15 cm squares to 50 cm squares and are a magnified view of the upper photograph. The lower right photograph is a magnified view of a 2 m square checkerboard with each checkerboard square 40 cm by 40 cm.

The second option is to point one DSLRs to the right and one to the left side of the trackline, with the inner edge of both cameras' field of view overlapping slightly at the centerline. This would provide coverage of a wider swath, ~ 1,500 m, instead of 753 m. This option would increase the area being surveyed but would not collect detailed information on the individuals seen or data on smaller or more cryptic species which are currently not being systematically collected during manned surveys. The peer review panel recommended that we deploy the second option to increase the number of large cetaceans recorded during the survey. However, walrus are a major species of concern near the exploration drilling operation and if better information on walrus are required by our permits, we will use option one during July to mid-September and switch to option two in mid-September. In mid-September walrus have started to move south of the exploration drilling operation but the main bowhead whale migration through the Chukchi Sea has not begun.

The proposed aerial photographic coverage with one DSLR pointed vertically would provide an Effective Strip Width (ESW) of 375 m (750/2) at 1000 ft. altitude. The ESW for manned surveys varies depending on the species being recorded due to different physical and behavioral characteristics of the species. The ESW for bowhead whales has varied between ~500 m and ~700 m during our 2006-2010 surveys in the Beaufort Sea. The ESW for belugas in the Chukchi Sea during the same period was ~300 m and the ESW for most other species was narrower. Thus the proposed coverage using a single DSLR swath width would be slightly lower for the most obvious species such as gray whales and bowheads, but better for smaller and more cryptic species such as belugas, minke whales, harbor porpoise (which would only be detected on the camera with the 100 mm lens). During the latter part of the season the coverage with two DSLR cameras would be about the same or better than during manned surveys.

The HD video that will be used is the Canon XF305 which as 1,920×1,080 resolution. This resolution is about 3 times better in width than the NTSC video (640×480) tested by Koski et al. (2009). This will allow the video to collect constant imagery along the flight path and will not require scanning back and forth as was done during earlier tests. It will be set to capture data along a 600 m wide swath at the same resolution as was tested during the Koski et al. (2009) study. By having the camera fixed on the trackline, the problems encountered by Koski et al. (2009) of uneven coverage, short time that many areas were in view, and different pixel size when the camera was pointed to the sides will be eliminated or reduced. Options for scanning and covering smaller or larger swaths will also be tested and compared to the data from the still camera.

Route planning and data storage software are off-the-shelf products assembled by VDOS LLC. The set up includes a harness to connect the camera and GPS to the Photo Coupler Controller which is connected to a GPS for triggering capture of images and recording of metadata for each image (Figure 7). The system can be powered by 10-32 volt DC or a custom power source and has a back-up battery power source to prevent interruption to data capture. Acquisition of imagery can be controlled from a laptop and/or preprogrammed route plan and there is live view of what the sensors are viewing on the water surface.

The system is “plug-and-play” and does not require input from persons on board the aircraft during the flight. The system can be pre-programmed to take photographs starting and stopping at predetermined locations or times. A laptop computer in the cockpit can be used to override the preprogrammed instructions and take additional images whenever desired.

Figure 7. Camera mount and associated data storage and control devices that can be mounted as a module in a Twin Otter.

Survey Timing and Frequency

Photographic surveys would start as soon as the ice management, anchor handler and drillship 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 about 1 July, surveys would be initiated on 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 drillship and the coastal saw-tooth pattern. Two surveys around the drillship and one survey of the nearshore sawtooth transects will be conducted each week, weather permitting. The surveys of offshore area around the drillship will take precedence over the sawtooth survey, but if weather does not permit surveying offshore, the nearshore survey will be conducted if weather permits.

Surveys in the Chukchi Sea are planned to start about 3 July to collect information on animal distribution before the first vessels enter the Chukchi Sea in early July. As in past years, we anticipate that we will not be permitted to fly the southern part of our survey grid near Point Lay before the end of the Beluga hunt, which normally ends in late June to early July. In past years permission to fly in that area has been granted about 15 July so surveys during 3 July to 15 July will be restricted to photographic surveys around the offshore exploration drilling operation or nearshore and coastal surveys from south of Wainwright to Barrow. A 3 July start date for surveys may not however be possible if Search and Rescue capability along the Chukchi Sea coast is not available at that time. Additionally, vessels associated with

the exploration drilling program may not yet be in the area. Should an aircraft go down having multiple vessels in the area to help with rescue operations could be extremely important.

Survey Pattern

The survey grid will be designed to cover a circular area with a radius 40 km around the drillship as shown in Figure 8. Transects will be spaced 7.2 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 circular survey area based on the start point. The total length of survey lines will be about 1,200 km and the exact length will depend on the location of the randomly selected start point.

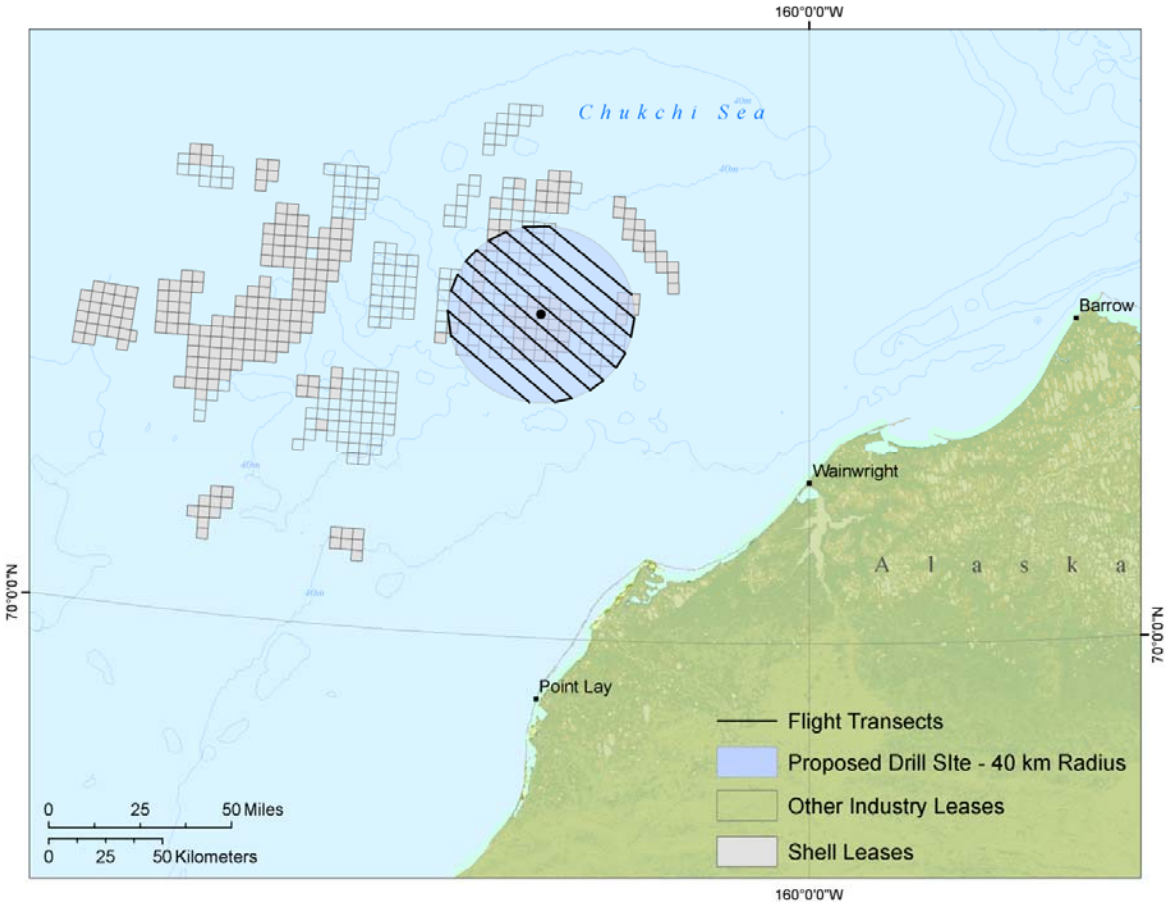


Figure 8. Aerial photographic survey design for the Chukchi Sea drill sites. This design maximizes the area covered in a single flight and assumes 7.2 km between transect lines.

Data Analyses

Following each survey, the imagery will be backed up on a second hard drive and stored at accommodations in Barrow until it can be transferred to Anchorage. The survey crew conducting the nearshore sawtooth surveys will conduct analyses of the photographic, and video imagery when time permits while they are in the field. Because nearshore surveys will be conducted only 1-2 days per week or less (they will be secondary to the offshore survey), PSOs will have time to conduct preliminary analyses of the imagery while in the field. The survey crew will make a single pass through the imagery

and enter the data into the same database format as is used for the manned aerial surveys and the photographic sightings will be reported in the same manner as the other PSO sightings. Programs to assist in the finding and identification of marine mammals in the imagery will not be available for the 2013 field season, but imagery obtained during 2013 will be used to develop those programs for future studies. If time permits, a second review of the data 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.

Verification of Imagery

Shell will install the same HD video and DSL camera system in a Twin Otter that will fly aerial surveys around their exploration drilling program in the Beaufort Sea. In the Beaufort Sea, we will use two cameras with 20 mm lenses to cover a swath 720 m on both sides of the flight line. That swath is equal to or greater than the ESW of observers during manned flights which will facilitate comparisons between the two data collection methods. That aircraft will have visual observers recording data using the same procedures as during earlier aerial surveys conducted in the Alaska Arctic. In addition, the digital imagery will also be collected during the nearshore surveys in the Chukchi Sea. This will permit a direct comparison of data collected by people on board an aircraft with data from digital photographs taken during the same survey. These comparisons will include, but not be limited to, the number and species detected by each method at each distance from the trackline, species identification, densities calculated using sightings data from each method allowing for appropriate correction factors, and comparison of age class and sex, when determinable, of sightings. The imagery will be reviewed two or more times to quantify biases associated with detectability of sightings in the digital imagery and to develop correction factors that can be used to account for missed sightings during single reviews of the imagery.

Other Imagery and Sensors

In addition to the imagery indicated above, Shell is examining systems that are in development that would allow collection of additional imagery. They include collection of multi-spectral/hperspectral imagery and a multi-camera system that would allow collection of imagery over a wider area. If these systems are ready for testing in 2013, Shell will consider incorporating these systems into the Chukchi Sea program.

Shell is also considering adding other types of sensors to the survey aircraft. One of these sensors, a sea surface temperature sensor, was tested successfully during 2009 surveys in the Canadian Beaufort Sea. We will be installing one of these sea surface temperature sensors on each of our aerial survey aircraft in 2013.

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 in 2013 as opportunities unfold and those surveys will be similar to the previous programs. 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, or after two complete surveys have been conducted of the offshore survey area for that week. The nearshore survey will be initiated about 3 July at the same time as the offshore photographic survey around the planned exploration drilling operation subject to previously indicated conditions. 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 difficult to detect from aircraft. 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 surveys conducted at 305 m above sea level.

Objectives

The aerial survey program objectives in 2013 will be:

- to collect data on the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea;
- to collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea; and
- to collect marine mammal sighting data using PSOs and digital media and compare the data recorded by the two methods.

Survey Procedures

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 (Figure 9). 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.

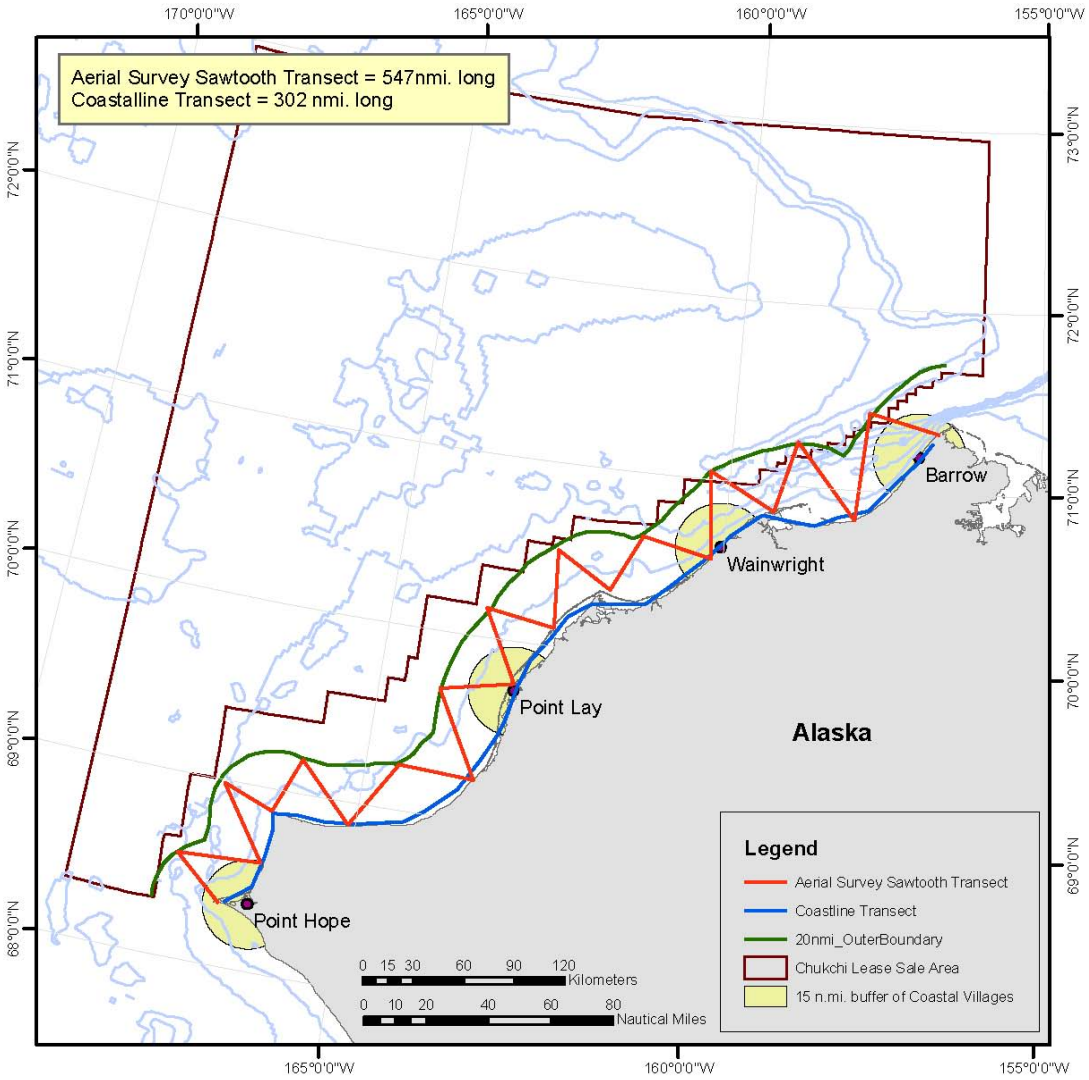


Figure 9. Aerial survey transects location and general pattern for the eastern Chukchi Sea, 2013. Specific transect start-/end-points will be altered randomly from survey to survey, and hunting areas will be avoided when hunting is occurring.

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). In accordance with anticipated stipulations in the LOA, survey aircraft will be flown at 1,500 ft (457 m) over the LBCHU. 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 normally available to subsistence hunters. If large concentrations of belugas are encountered during the survey, the survey may be interrupted to photograph the groups to obtain better counts of the number of animals present. If whales are photographed in lagoons or other shallow-water concentration areas, the aircraft will climb to ~10,000 ft (3,050 m) altitude to avoid disturbing the whales and cause them to leave the area. If whales are in offshore areas, the aircraft will climb high enough to include all whales 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. Additionally, if large groups of other marine mammals are encountered on the surveys, such as the large aggregations of walruses seen in 2007 and 2010, we will attempt to photograph the animals and provide location information to interested stakeholders.

Five PSOs will be aboard the aircraft during surveys. Two observers (primary observers) will be looking for marine mammals within 2.5 km of the survey track line; one at a bubble window on each side of the aircraft. A third person will record data and a fourth person will rest and alternate with the other observers throughout the flight so that none of the primary observers are on duty for more than two hours at a time. The fifth observer will serve as an ice observer and will record data pertinent to Shell's ice observation program. When sightings are made, observers will notify the data recorder of the species or species class of the animal(s) sighted, the number of animals present, and the lateral distance (inclinometer angle) of the animals from the flight path of the aircraft. This information, along with time and location data from an onboard GPS, will be entered into a database. The sighting information and additional data on each sighting will be entered into a digital voice recorder and entered into the database after the survey and will be used to check the data entry during the survey.

At the start of each transect, the primary observer will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction (°T) and outside air temperature (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea conditions (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-min intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables on the probability of detecting animals (see Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002, Manly et al. 2004).

The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects. The primary data logger will be a laptop computer with custom GPS recording and data entry software. The computer will automatically store the time and aircraft position at pre-selected intervals (typically at 6 seconds for straight-line transect surveys) and store the records to a file as they are obtained. Records can be edited or supplemented while in flight or after the flight.

Coordination with Other Aerial Surveys

The BOEM, the NMFS, the USFWS, the NSB, or other organizations may also conduct aerial surveys in the Chukchi Sea during the exploration drilling season. Shell will consult with any groups or organizations conducting aerial surveys along the eastern Chukchi Sea coast regarding coordination during the exploration drilling season. The objectives will be:

- to ensure aircraft separation when both crews conduct surveys in the same general region;
- to coordinate the 2013 aerial survey projects in order to maximize consistency and minimize duplication; and
- to maximize consistency with previous years' efforts insofar as feasible.

Analysis of Aerial Survey Data

During the field program, preliminary maps and summaries of the daily surveys will be provided to NMFS as normally required by the terms of the IHA. While in the field, data will be checked for entry errors and files will be backed up to CDs or portable memory drives and transferred to the office in Anchorage via the internet. Reporting of results will focus on the distribution of the observed species along the coast and the seasonal timing (if any) of the observed species.

Beaufort Sea Aerial Survey Program

Objectives

An aerial survey program will be conducted in support of the exploration drilling program in the Beaufort Sea during the summer and fall of 2013. In addition to the standard data collection by PSOs as has been done during 2006-2010 and in 2012, digital cameras and high definition (HD) video cameras on the survey aircraft will capture imagery that can later be compared to data collected by the PSOs. A program of this type was successfully operated in 2012 and will again be used in 2013. The exploration drilling program and geotechnical studies may start in the Beaufort Sea as early as 10 July 2013. The objectives of the aerial survey will be:

- to advise operating vessels as to the presence of marine mammals (primarily cetaceans) in the general area of operation;
- to collect and report data on the distribution, numbers, movement and behavior of marine mammals near the exploration drilling operations with special emphasis on migrating bowhead whales;
- to support regulatory reporting related to the estimation of impacts of exploration drilling operations on marine mammals;
- to investigate potential deflection of bowhead whales during migration by documenting how far east of exploration drilling operations a deflection may occur, and where whales return to normal migration patterns west of the operations;
- to collect marine mammal sighting data using both PSOs and digital media, and after the field season, to compare the data recorded by the two methods; and
- to monitor the accessibility of bowhead whales to Inupiat hunters.

Safety

Safety will be of primary importance in all decisions regarding the planning and conduct of the aerial surveys. Safety-related considerations during planning have included choice of aircraft, aircraft operator, and pilots; outfitting of the aircraft; lengths and locations of survey grids; and safety training. Safety during aerial survey operations will include careful and judicious consideration of weather and avoidance of flight in questionable conditions. Although the pilots will have ultimate authority, the aerial survey crew will also be required to make their own judgments and to avoid flying in questionable circumstances. To this end, the aerial survey teams will have a crew leader with experience conducting this type of survey in arctic conditions, and will have the authority to cancel or (in agreement with the pilots) amend flight operations as necessary for safety.

Selection of Aircraft

Specially-outfitted deHavilland Twin Otter (Twin Otter) aircraft are expected to be the survey aircraft and have an excellent safety record operating in the Arctic and Antarctic. These aircraft will be specially modified for survey work and have been used extensively by NMFS, Alaska Department of Fish and Game (ADF&G), Coastal and Offshore Pacific Corporation (COPAC), NSB, and LGL during many marine mammal projects in Alaska, including Industry funded projects as recent as the 2006–2008, 2010, and 2012 seasons and in northern Canada. The aircraft will be provided with a comprehensive set of survival equipment appropriate to offshore surveys in the Arctic. For safety reasons, the aircraft will be operated with two pilots. The aircraft will be outfitted with a deHavilland-approved camera port to house collection of digital imagery below the floor of the aircraft so that movements in the aircraft are not compromised by the additional equipment.

Survey Procedures

Flight and Observation Procedures

Aerial survey flights will begin 5 to 7 days before operations at the exploration well sites get underway. Surveys will be flown daily throughout exploration drilling operations, weather and flight conditions permitting, and continued for 5 to 7 days after all activities at the site have ended.

The aerial survey procedures will be generally consistent with those used during earlier industry studies (Davis et al. 1985; Johnson et al. 1986; Evans et al. 1987; Miller et al. 1997, 1998, 1999, 2002; Brandon et al. 2011; Thomas and Koski 2011). This will facilitate comparison and pooling of data where appropriate. However, the specific survey grids will be tailored to Shell's operations, and in 2013 they have been modified to obtain higher levels of effort within 30 km of the exploration drilling operations as described below. During the 2013 exploration drilling season, Shell will coordinate and cooperate with the aerial surveys conducted by BOEM/NMFS and any other groups conducting surveys in the same region.

It is understood that the timing, duration, and location (between identified well sites) of Shell's exploration drilling operations are subject to change as a result of unpredictable weather and ice conditions, as well as regulatory and stakeholder concerns. The aerial survey design is flexible and able to adapt at short notice to changes in the operations.

For marine mammal monitoring flights, aircraft will be flown at ~120 knots ground speed and usually at an altitude of 1,000 ft (305 m). Flying at a survey speed of 120 knots greatly increases the amount of area

that can be surveyed, given aircraft and pilot daily flight time limitations, with minimal effect on the ability to detect bowhead whales. Surveys in the Beaufort Sea are directed at bowhead whales and an altitude of 900-1,000 ft (274-305 m) is the lowest survey altitude that can normally be flown without concern about potential aircraft disturbance; it is also the altitude recommended by NMFS for IHA monitoring efforts for bowhead whales. Aerial surveys at an altitude of 1,000 ft (305 m) do not provide much information about seals and small cetaceans such as harbor porpoise, but they are suitable for both bowhead and beluga whales. The need for a 900-1000+ ft cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher minimum altitude for surveys (e.g. 1,500 ft [457 m]) would result in a significant reduction in the number of days where surveys would be possible, impairing the ability of the aerial program to meet its objectives. All other Shell-associated aircraft during the 2013 exploration drilling program shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing, taking off, under poor weather (low ceilings) conditions, engaged in providing assistance to a whaling vessel in distress, or any other emergency situations.

Two primary observers will be seated at bubble windows on either side of the aircraft and a third observer will observe part-time and record data the rest of the time. A fourth observer will be present on the aircraft and will rest when not at one of the three positions noted above. Observers will rotate among the four positions so that individual observers do not observe for longer than two hours continuously. A fifth observer will collect ice observations. All observers will be seated at bubble windows to facilitate downward viewing. For each marine mammal sighting, the observer will dictate the species, number, size/age/sex class when determinable, activity, heading, swimming speed category (if traveling), sighting cue, ice conditions (type and percentage), and inclinometer reading to the marine mammal into a digital recorder. The inclinometer reading will be taken when the animal's location is 90° to the side of the aircraft track, allowing calculation of lateral distance from the aircraft trackline.

Transect information, sighting data and environmental data will be entered into a GPS-linked computer by the third observer, and simultaneously recorded on digital voice recorders for backup and validation. At the start of each transect, the observer recording data will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction in degrees True North (°T) and outside air temperature in degrees Celsius (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-minute intervals along the transect. This will provide environmental data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to the drillship) on the probability of detecting animals (see Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002). The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects.

Photographic and Video Imagery

Identical equipment and procedures to those described above for the Chukchi Sea photographic study will be used in the Beaufort Sea photographic study. DSLR and video cameras will be operated during all aerial surveys in the Beaufort Sea during 2013 and will collect imagery along the trackline concurrent with observations being made by PSOs. Data collected during these surveys will permit comparisons

between data obtained by PSOs versus those that can be obtained from digital still images and video. The rationale for this component of the study is to validate the ability of the sensors to collect high quality data that will be collected using UAS in the future, and to obtain information on possible biases of future UAS-collected data in comparison to manned surveys.

Supplementary Data

Ice observations during aerial surveys will be recorded and satellite imagery may be used, where available, during post-season analysis to determine ice conditions adjacent to the survey area. These are standard practices for surveys of this type, and are necessary in order to interpret factors responsible for variations in sighting rates.

In 2013, digital single lens reflex cameras and video will provide a permanent record of the sea surface within 700 m of the trackline during all flights. These data will also provide high resolution information on sea and ice conditions during the survey which can be used to supplement and validate data recorded by PSOs during the survey.

Shell will, as a high priority, assemble the information needed to relate marine mammal observations to the locations of the *Kulluk* and other activities, and to the estimated received levels of industrial sounds at mammal locations. During the aerial surveys, Shell will record relevant information on other industry vessels, whaling vessels, low-flying aircraft, or any other human activities that are seen in the survey area.

Coordination with BOEM/NMFS Aerial Surveys

BOEM/NMFS are planning to continue its wide-ranging aerial surveys of bowhead whales and other marine mammals in the Beaufort Sea during the autumn of 2013. In 2013, the surveys will be contracted to the National Marine Mammal Laboratory (NMML) in Seattle. These surveys include the area where exploration drilling activities will occur. Shell will co-ordinate with BOEM/NMML to share data, both during the drilling season and for use in analyses and reports.

Shell will also consult with BOEM/NMML regarding coordination during the drilling season and real-time sharing of data. The aims will be:

- to ensure aircraft separation when both crews conduct surveys in the same general region;
- to coordinate the 2013 aerial survey projects in order to maximize consistency and minimize duplication;
- to use data from BOEM's broad-scale surveys to supplement the results of the more site-specific Shell surveys for purposes of assessing the effects of exploration drilling activities on whales and estimating "take by harassment";
- to maximize consistency with previous years' efforts insofar as feasible.

It is expected that raw bowhead sighting and flightline data will be exchanged between BOEM and Shell on a daily basis during the drilling season, and that each team will also submit its sighting information to NMFS in Anchorage each day. After the Shell and BOEM data files have been reviewed and finalized, they will be exchanged in digital form.

Shell is not aware of any other related aerial survey programs presently scheduled to occur in the Alaskan Beaufort Sea in areas where Shell is anticipated to be conducting exploration drilling operations during

July–October 2013. If another aerial survey project were planned, Shell would seek to coordinate with that project to ensure aircraft separation, maximize consistency, minimize duplication, and share data.

Survey Design

During the late summer and fall, the bowhead whale is the primary species of concern, but belugas and gray whales are also present. Bowheads and belugas migrate through the Alaskan Beaufort Sea from summering areas in the central and eastern Beaufort Sea and Amundsen Gulf to their wintering areas in the Bering Sea (Clarke et al. 1993; Moore et al. 1993; Miller et al. 2002). Small numbers of bowheads are sighted in the eastern Alaskan Beaufort Sea starting mid-August and near Barrow starting late August, but the main migration does not start until early September. Recent government and industry surveys (COMIDA/BWASP 2009; Funk et al. 2010) and GPS tagging (ADF&G 2009) have also recorded some bowheads in the western Alaskan Beaufort Sea in July and August. The bowhead migration tends to be through nearshore and shelf waters, although in some years small numbers of whales are seen near the coast and/or far offshore. Bowheads frequently interrupt their migration to feed (Ljungblad et al. 1986; Lowry 1993; Landino et al. 1994; Würsig et al. 2002; Lowry et al. 2004; Funk et al. 2010) and their stop-overs vary in duration from a few hours to a few weeks (Koski et al. 2002). A commonly used feeding area is in and near Smith Bay, east of Barrow. Less consistently used feeding areas are in coastal and shelf waters near and east of Kaktovik. In 2007 and 2008, bowhead whales also used areas near Camden Bay to feed during the migration (Ireland et al. 2008; Funk et al. 2010).

To address concerns regarding deflection of bowheads at greater distances, the survey pattern around exploration drilling operations has been designed to document whale distribution from about 25 mi (40 km) east of the exploration drilling operations to about 37 mi (60 km) west of operations (Figure 10). Aerial surveys will be conducted daily starting 5 to 7 days before exploration drilling operations begin until a few days after exploratory drilling activities end but will not extend past October 31st 2013.

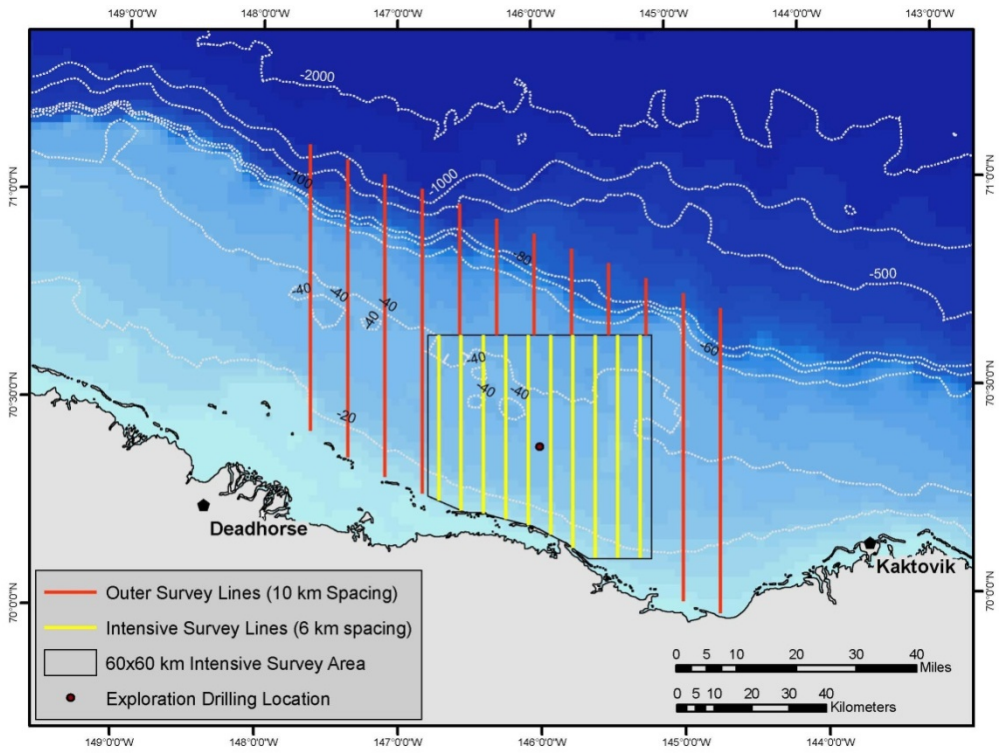


Figure 10. Central Alaskan Beaufort Sea showing a representative aerial survey pattern that will be flown daily during summer and fall. The survey grid will be moved east or west depending on the precise location of the Kulluk and lines will be shifted slightly within the grid for each survey in order to randomize their location and meet sampling design objectives. See text for explanation of the intensive and outer survey lines.

Bowhead whale movements during the late summer/autumn are generally from east to west, and transects should be designed to intercept rather than parallel whale movements. The transect lines in the grid will be oriented north-south and randomly shifted in the east-west direction for each survey by no more than the transect spacing. The survey grid will total about 808 mi (1,300 km) in length, requiring ~6 hours (hr) to survey at a speed of 137 mi/hr (220 km/hr) (120 knots), plus ferry time. Completion of the entire grid will require 10 hours of total flight time, which is the maximum time that pilots can fly in a day. Exact lengths and durations will vary somewhat depending on the position of the exploration drilling operation and thus of the grid, the sequence in which lines are flown (often affected by weather), and the number of refueling/rest stops.

Weather permitting, transects flown during each flight will be flown in sequence but randomly from west to east or east to west. This approach was recommended by the Peer Review Panel evaluating Shell's monitoring plan, although this may, when surveys are flown from east to west, result in double counting whales that are (predominantly) migrating westward. The survey pattern around the exploration drilling operation is designed to monitor the distribution of whales around the exploration drilling operation.

A power analysis was conducted of the ability of our past surveys to detect differences in whale density assuming deflection at various distances from the drilling operation. The power analysis showed that the equal spacing of transects used during recent surveys would not allow detection of avoidance at close range because survey effort near the activity was too low. Figure 10 shows a survey design developed for

the 2012 field season based on the output of the power analysis that maximizes the potential to detect differences in bowhead whale density within 20 km of the drilling operation. It includes an intensive grid covering out to ~30 km from the exploration drilling operation and an outer or extensive grid extending east, north and west of the intensive grid. The spacing between the lines in the intensive grid is ~6 km and spacing between the lines in the outer grid is ~10 km. A similar survey pattern will be used in 2013.

Analysis of Aerial Survey Data

During the field program, preliminary maps and summaries of the daily surveys will be provided to NMFS as normally required by the terms of the IHA, and USFWS and BOEM (if so stipulated). While in the field, data will be checked for entry errors and files will be backed up to CDs or portable memory drives and sent via the internet to the LGL office in Anchorage. Two levels of analyses will be conducted at the end of the season. The first level will consist of basic summaries that are required for the 90-day report specified by the IHA. These include summaries of numbers of marine mammals seen, survey effort by date, maps summarizing sightings, and estimates of numbers of marine mammals that are "taken" according to NMFS criteria. The data from the photographic survey will be analyzed as time permits during the season; the majority of the analyses of the photographs and video will be conducted after the field season, unless poor weather prevents much surveying.

The second level of analyses will be presented in a subsequent comprehensive report. The comprehensive report will provide more detailed analyses of the data to quantify the effect of the exploration drilling program on the distribution and movements of marine mammals. Real-time data from the manned surveys will be the primary source of information and it will be integrated with similar data from earlier years. The comprehensive report will also incorporate the data from the photographic surveys and will include comparisons of the photographic data with those collected in real time by the PSOs. This will form the basis for interpretation of data obtained during photographic surveys in the Chukchi Sea in 2012-2013 and will be the basis for interpretation of future data collected using the same sensors in UAS.

Estimation of Number of Exposures

Shell has used the following methodology, which was developed using past studies in the Beaufort and Chukchi sea regions (Miller et al. 1999; Haley and Ireland 2006) and other areas of the world (Lawson et al. 1998; Holst et al. 2005; Ireland et al. 2005), for estimating the numbers of marine mammals that are exposed to various sound levels. Depending on the context and level of exposure, some of these animals are considered to be "taken" by harassment (as defined by NMFS). These estimates of number of animals exposed require estimating the numbers of animals present near or passing the exploration drilling and geophysical and geotechnical surveys during periods without exploration activity and assuming that similar numbers would have passed during those activities, if the activities were not conducted. The planned approach has been accepted by NMFS as satisfying the requirements for "take" estimates for previous monitoring programs.

The criteria to be used in tabulating and estimating numbers of cetaceans potentially exposed to various sound levels will be consistent with those used during previous related projects in 1996-2010, unless otherwise directed by NMFS. Only cetaceans will be addressed using the aerial survey data because the altitude of the surveys is too high to reliably detect and identify pinnipeds. As in previous studies, Shell anticipates that there will be four components:

1. *Numbers of cetaceans observed within the area ensonified strongly by the exploration drilling operations.* For cetaceans, Shell will estimate the numbers of animals exposed to received rms levels of sounds exceeding 120, 160 dB and 180 dB re 1 μPa, as required by NMFS.

2. *Numbers of cetaceans observed showing apparent reactions to exploration drilling operations, e.g., heading in an "atypical" direction.* Animals exhibiting apparent responses to the activities will be counted as affected by the programs if they were exposed to sounds from those activities.

3. *Numbers of cetaceans estimated to have been subjected to sound levels ≥120, ≥160 and ≥180 dB re 1μ Pa rms when no monitoring observations were possible*. This will involve using the observations from the survey aircraft (Shell and BOEM/NMFS), supplemented by relevant vessel-based observations, to estimate how many cetaceans were exposed over the full course of Shell's 2012 exploration drilling season to situations where received sound levels were ≥120, ≥160 and ≥180 dB rms. In the case of the bowhead whale, Shell will estimate the proportions of the observed whales that were close enough to shore to have passed through the area where exposure might occur, and could have passed while exploration drilling operations were underway. Shell's aerial survey design, together with the complementary aerial surveys to be conducted by BOEM/NMFS, will provide the needed data.

4. *The number of bowheads whose migration routes came within 12 mi (20 km) of the drilling activity, or would have done so if they had not been displaced farther offshore, will be estimate*d. If the 2012 data indicate that the avoidance distance exceeds 12 mi (20 km), the larger avoidance distance will also be used for estimating the numbers of whales potentially responding to the exploration activity. These estimates will be obtained by determining the displacement distance based on the aerial survey results, and then estimating how many bowheads were likely to approach the avoided area during times while the *Kulluk* and support vessels were present.

Effects of Exploration Drilling Program on Bowhead Migration

The location of the bowhead migration corridor in 2013 will be determined by examining data from periods with exploration drilling activities and data from east of those operations. The BOEM/NMFS aerial survey data will be a useful supplement for areas well east of the drilling locations. Shell will contrast the numbers of bowhead sightings and individuals vs. distance from shore:

- during periods with vs. without exploration drilling operations, and
- near vs. east vs. west of the exploration areas.

The distance categories will be linked to estimated received sound levels based on the results from the acoustic measurement task. Analyses will be done on a sightings-per-unit effort basis to allow meaningful interpretation even though aerial survey effort is inevitably inconsistent at different distances offshore.

To determine how far east, north and west displacement effects (if any) extend, additional analyses will be conducted on bowhead sightings and survey effort in relation to distance and bearing from the exploration drilling operations during times with and without operations. Shell anticipates applying a

logistic or Poisson regression approach to assess the effects of distance and direction from the exploration drilling operations on sighting probability of bowhead whales, allowing for the confounding influence of sightability (sea state, ice conditions, etc.) and other covariates. Such an approach has been used extensively in analyses of whale and seal distribution in the Beaufort Sea (Manly et al. 2004; Moulton et al. 2005). Other analyses that may be useful to describe the effects of the exploration drilling operation on the bowhead migration path, including summaries of headings, behavior and swimming speeds, will be included in the technical report.

The data from the current survey may not provide enough sightings to be able to quantify the effects of Shell's 2013 activities on the bowhead whale migration path. That could occur if Shell's operations in the Beaufort Sea during the bowhead whale migration season were limited due to ice or other factors, or if 2013 is a year when weather conditions are poorer than average, which would limit the periods when surveys could be conducted.

The aerial survey data pertaining to other species of marine mammals will also be mapped and analyzed insofar as this is useful. However, the main migration corridor of belugas is far offshore, and generally north of the survey area proposed here. Few gray whales and walrus are likely to be seen because of their rarity in the Beaufort Sea area (although gray whales were seen in the area in 1998 (Miller et al. 1999) and small numbers have been seen during several recent surveys by BOEM, formerly as Minerals Management Service (MMS) (Treacy 1998, 2000, 2002) and LGL (Brandon et al. 2011; Thomas and Koski 2011). Therefore, the proposed aerial surveys are expected to document the infrequent use of continental shelf waters of the Beaufort Sea by beluga whales, gray whales and walrus, and detailed analyses for these species probably will not be warranted. Seals cannot be surveyed quantitatively by aerial surveys at altitudes 900-1,500 ft (274- 457 m) over open water. The aerial surveys will provide only incidental data on the occurrence of bearded and especially ringed seals in the area.

Comprehensive Report on Industry Activities and Marine Mammal Monitoring Efforts in the Beaufort and Chukchi Seas

Following the 2013 exploration drilling season a comprehensive report describing the vessel-based, aerial, and acoustic monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities, and other activities that occur in the Beaufort and/or Chukchi Seas, and their impacts on marine mammals. The report will help to establish long-term data sets that can assist with the evaluation of changes in the Chukchi and Beaufort Sea ecosystems. The report will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior.

Literature Cited

ADF&G (Alaska Department of Fish and Game). 2009. Satellite Tracking of Western Arctic Bowhead Whales. Preliminary reports and summaries available at: http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead

Blackwell, S.B., C.R. Greene, H.K. Kim, T.L. McDonald, C.S. Nations, R.G. Norman, and A. Thode. 2010. Beaufort Sea acoustic monitoring program. (Chapter 9) *In*: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

Blackwell, S.B., R.G. Norman, C.R. Greene Jr., and W.J. Richardson. 2007. Acoustic measurements. p. 4-1 to 4-52 In: Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July-September 2006: 90-day report. LGL Rep. P891-1. Rep. from LGL Alaska Res. Assoc. Inc., Anchorage, AK, and Greeneridge Sciences Inc., Santa Barbara, CA, for Shell Offshore Inc., Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish & Wildl. Serv., Anchorage, AK. 199 p.

Brandon, J.R., T. Thomas, and M. Bourdon. 2011. Beaufort Sea aerial monitoring program. (Chapter 7) *In*: Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Clarke, J.T., S.E. Moore, and M.M. Johnson. 1993. Observations on beluga fall migration in the Alaskan Beaufort Sea, 1982-87, and northeastern Chukchi Sea, 1982-91. Rep. Int. Whal. Comm. 43:387-396.

COMIDA. 2009. Chukchi Offshore Monitoring in Drilling Area. National Marine Mammal Laboratory Cetacean Assessment and Ecology Program, Bowhead Whale Aerial Surveys: Preliminary Data. Available at: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php.

Davis, R.A., W.R. Koski, W.J. Richardson, C.R. Evans and W.G. Alliston. 1982. Distribution, numbers and productivity of the Western Arctic stock of bowhead whales (Balaena mysticetus) in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. SC/34/PS20. Int. Whal. Comm., Cambridge, UK. 13 p

Evans, C.R., S.R. Johnson, and W.R. Koski. 1987. Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986: Aerial surveys of whale distribution. Rep. by LGL Ltd., King City, Ontario, for Shell Western E& P Inc., Anchorage. 69 p.

Funk, D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort Seas, Open Water Seasons 2006–2008. LGL Alaska Rep. P1050-1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., JASCO Research Ltd. and Greeneridge Sciences, Inc. for Shell Offshore Inc, Houston, TX, ConocoPhillips Alaska Inc., Anchorage, AK and Nat. Mar. Fish. Serv., Silver Spring, MD. and U.S. Fish and Wildlife Service. 488 p. plus appendices.

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

Haley, B. and D. Ireland. 2006. Marine mammal monitoring during University of Alaska Fairbank's marine geophysical survey across the Arctic Ocean, August-September 2005. LGL report 4122-3. Report from

LGL Alaska Research Associates, Anchorage, AK and LGL Ltd, King City, Ont., for Geophysical Institute, University of Alaska, Fairbanks, AK, and Nat. Mar. Fish. Serv., Silver Spring, MD. 80 p.

Hannay, D. and G. Warner. 2009. Acoustic measurements of airgun arrays and vessels. Chapter 3 *In*: Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, D. Hannay (eds.). Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-day report. LGL Rep. P1049-1. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc, Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 277 pp, plus appendices.

Harris, R.E., G.W. Miller, R.E. Elliott and W.J. Richardson. 1997. Seals [1996]. p. 4-1 to 4-42 In: W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1996: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2121-2. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

Harris, R.E., A.N. Balla-Holden, S.A. MacLean and W.J. Richardson. 1998. Seals [1997]. p. 4-1 to 4-54 In: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of BP Exploration (Alaska's) open-water seismic program in the Alaskan Beaufort Sea, 1997. LGL Rep. TA2150-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and U.S. Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 318 p.

Heide-Jørgensen, M.P., L. Witting, K.L. Laidre, R.G. Hansen and M. Rasmussen. 2010. Fully corrected estimates of common minke whale abundance in West Greenland in 2007. J. Cetacean Res. Manage. 11(2):75-82.

Holst, M., M.A. Smultea,. W.R. Koski, and B. Haley. 2005. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's marine seismic program off the Northern Yucatán Peninsula in the Gulf of Mexico, January–February 2004. LGL Rep. TA2822 31. Rep. from LGL Ltd., King City, Ont., for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and Nat. Mar. Fish. Serv., Silver Spring, MD. 96 p.

Ireland D.S., D.W. Funk, R. Rodrigues, and W.R. Koski (eds.). 2008. Joint Monitoring Program in the Chukchi and Beaufort Seas, July-November 2007. LGL Alaska Rep. P971-1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., and JASCO Research Ltd. and Greeneridge Sciences, Inc. for Shell Offshore Inc, Houston, TX, ConocoPhillips Alaska Inc., Anchorage, AK and Nat. Mar. Fish. Serv., Silver Spring, MD and U.S. Fish and Wildlife Service. 445 p. plus appendices.

Ireland, D.S., R. Rodrigues, D. Funk, W.R. Koski, D. Hannay. (eds.). 2009. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. In the Chukchi and Beaufort Seas, July–October 2008 : 90-day report. LGL Rep. P1049-1. Rep from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. For Shell Offshore Inc., Nat. Mar. Fish. Serv., and U.S. Fish and Wild. Serv. 277 pp, plus appendices.

Ireland, D., M. Holst, and W.R. Koski. 2005. Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic program off the Aleutian Islands, Alaska, July–August 2005. LGL Rep. TA2822-32. Rep. from LGL Ltd., King City, Ont., for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and Nat. Mar. Fish. Serv., Silver Spring, MD. 67 p.

Koski, W.R. and R.A. Davis. 1980. Studies of the late summer distribution and fall migration of marine mammals in NW Baffin Bay and E Lancaster Sound, 1979. Rep. from LGL Ltd., Toronto, Ont., for Petro-Canada Expl., Calgary, Alb. 214 p.

Koski, W.R. and Davis, R.A. 1994. Distribution and numbers of narwhals (*Monodon monoceros*) in Baffin Bay and Davis Strait. Meddr. om Grønland, Biosci. 39:15-40.

Koski, W.R., R.A. Davis and K.J Finley. 2002. Distribution and abundance of eastern Canadian Arctic belugas. Pages 87-126. In: Ø. Wigg and M.P. Heidi-Jørgensen (eds). Belugas and Narwhals. NAMMCO Sci. Publ. No. 4.

Koski, W.R.., T. Allen, D. Ireland, G. Buck, P.R. Smith, A.M. Macrander, C. Rushing, D.J. Sliwa, and T.L. McDonald. 2009. Evaluation of an unmanned airborne system for monitoring marine mammals. Aquat. Mammals 35(3):347-357.

Landino, S.W., S.D. Treacy, S.A. Zerwick, and J.B. Dunlap. 1994. A Large aggregation of bowhead whales (*Balaena mysticetus*) feeding near Barrow, Alaska, in late Oct. 1992. Arctic 47(3):232-235.

Lawson, J.W., W.R. Koski, D.H. Thomson, and W.J. Richardson. 1998. Chapter 4.7 Marine Mammals: Environmental Consequences. *In*: Environmental Impact Statement/Overseas Environmental Impact Statement Point Mugu Sea Range. Prepared by LGL Limited, King City, Ontario, and Ogden Environmental and Energy Services, Santa Barbara, CA, for Dep. Navy, Naval Air Warfare Center Weapons Division, Point Mugu, CA and Southwest Division Naval Facilities Engineering Command, San Diego, CA.

Ljungblad, D.K., S.E. Moore, and J.T. Clarke. 1986. Assessment of bowhead whale (*Balaena mysticetus*) feeding patterns in the Alaskan Beaufort and northeastern Chukchi seas via aerial surveys, fall 1979-84. Rep. Int. Whal. Comm. 36:265-272.

Lowry, L.F. 1993. Foods and feeding ecology. p. 201-238 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds) The Bowhead Whale. Special Publication. No. 2. Society for Marine Mammalogy, Lawrence, Kansas. 787 p.

Lowry, L.F., G. Sheffield, and J.C. George. 2004. Bowhead whale feeding in the Alaskan Beaufort Sea based on stomach contents analyses. J. Cetacean Res. Manage. 63: 223.

Manly, B.F.J., V.D. Moulton, R.E. Elliott, G.W. Miller, and W.J. Richardson. 2004. Analysis of covariance of fall migrations of bowhead whales in relation to human activities and environmental factors, Alaskan Beaufort Sea: Phase I, 1996-1998. Report by LGL Limited, King City, ON, and WEST Inc., Cheyenne, WY, for Minerals Management Service, Herndon, VA and Anchorage, AK. 128 p.

Miller, G.W., R.E. Elliott, W.R. Koski and W.J. Richardson. 1997. Whales. p. 5-1 to 5-115 *In*: W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1996: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2121-2. Rep. from LGL Ltd., King City, ON and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc. and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 245 p.

Miller, G.W., R.E. Elliott, and W.J. Richardson. 1998. Whales. p 5-1 to 5-123 *In*: W.J. Richardson (ed.), Northstar marine mammal monitoring program, 1997: marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. LGL Rep. 2150-3. Rep. from LGL Ltd., King City, ON and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc. and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 318 p.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. p. 5-1 to 5-109 *In*: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and U.S. Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G.W., R.E. Elliott, T.A. Thomas, V.D. Moulton, and W.R. Koski. 2002. Distribution and numbers of bowhead whales in the eastern Alaskan Beaufort Sea during late summer and autumn, 1979-2000. p. 9-1 to 9-39 (Chap. 9) *In*: W.J. Richardson and D.H. Thomson (eds.), Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information, vol. 1. OCS Study MMS 2002-012;

LGL Rep. TA2196-7. Rep. from LGL Ltd., King City, Ont., for U.S. Minerals Manage. Serv., Anchorage, AK, and Herndon, VA. 420 p. NTIS PB2006-100382.

Moore, S.E., J.T. Clarke, and M.M. Johnson. 1993. Beluga distribution and movements offshore northern Alaska in spring and summer, 1980-84. Rep. Int. Whal. Comm. 43:375-86.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-48 In: W.J. Richardson (ed.), Marine mammal and acoustical monitoring of WesternGeco's open water seismic program in the Alaskan Beaufort Sea, 2001. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for WesternGeco, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. LGL Rep. TA2564-4.

Moulton, V.D., W.J. Richardson, R.E. Elliott, T.L. McDonald, C. Nations, and M.T. Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed seals (Phoca hispida) of the Alaskan Beaufort Sea. Mar. Mamm. Sci. 21(2):217-242.

NMFS. 2000. Small takes of marine mammals incidental to specified activities; marine seismic-reflection data collection in southern California/Notice of receipt of application. Fed. Regist. 65(60, 28 Mar.):16374-16379.

Reiser, C.M., D. Funk, R. Rodrigues, and D. Hannay. 2010. Marine mammal monitoring and mitigation during open water shallow hazards and site clearance surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-day Report. LGL Report P1112-1 prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, and JASCO Research Ltd., Victoria, BC, for Shell Offshore Inc., Houston TX, the National Maine Fisheries Service, Silver Springs, MD, and U.S. Fish and Wildlife Service, Anchorage, AK.

Richard, P.R., J.R. Orr and D.G. Barber. 1990. The distribution and abundance of belugas, *Delphinapterus leucas*, in the eastern Canadian subarctic waters: a review and update. Can. Bull. Fish. Aquat. Sci. 224:23-38.

Richard, P.R., P. Weaver, L. Dueck and D. Barber. 1994. Distribution and numbers of Canadian High Arctic narwhals (*Monodon monoceros*) in August 1984. Meddr. om Grønland, Biosci. 39:41-50.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA.

Thomas, T. and W.R. Koski. 2011. Chukchi Sea nearshore aerial surveys. (Chapter 4) In: Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Thomas, T.A., W.R. Koski, and W.J. Richardson. 2002. Correction factors to calculate bowhead whale numbers form aerial surveys of the Beaufort Sea. Chapter 15. In: W.J. Richardson and D.H. Thomson (eds.). Bowhead whale feeding in the eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information. 28pp. OCS Study MMS 2002-012.

Treacy, S.D. 1998. Aerial surveys of endangered whales in the Beaufort Sea, fall 1997. OCS Study MMS 98-059. U.S. Minerals Manage. Serv., Anchorage, AK. 143 p.

Treacy, S.D. 2000. Aerial surveys of endangered whales in the Beaufort Sea, fall 1998-1999. OCS Study MMS 2000-066. U.S. Minerals Manage. Serv., Anchorage, AK. 135 p.

Treacy, S.D. 2002. Aerial surveys of endangered whales in the Beaufort Sea, fall 2000. OCS Study MMS 2002-014. U.S. Minerals Manage. Serv., Anchorage, AK. 111 p.

Witting, L. and D.G. Pike. 2005. Applying aerial digital photo based strip-width surveys to minke whales. SC/57/AWMP2 presented to the IWC Scientific Committee, Ulsan, Korea, 26 May–10 June 2005. 15 p.

Würsig, B., W.R. Koski, T.A. Thomas, and W.J. Richardson. 2002. Activities and behavior of bowhead whales in the eastern Alaskan Beaufort Sea during late summer and autumn. Chapter 12. In: W.J. Richardson and D.H. Thomson (eds). Bowhead whale feeding in the eastern Alaskan Beaufort Sea: Final Report. Report by LGL Ltd., King City, for Minerals Management Service, Anchorage, AK.

THIS PAGE
INTENTIONALLY
LEFT BLANK

Attachment B

Plan of Cooperation 2013 Proposed Open Water Marine Surveys Program
Chukchi and Beaufort Seas, Alaska

Plan of Cooperation
2013 Proposed Open Water Marine Surveys Program 2013
Chukchi Sea and Beaufort Sea, Alaska

December 2012

Prepared by
Shell Exploration and Production, Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

Table of Contents

List of Tables

List of Figures

List of Attachments

THIS PAGE
INTENTIONALLY
LEFT BLANK

ACRONYMS & ABBREVIATIONS

4MP	Marine Mammal Monitoring and Mitigation Plan
AEWC	Alaska Eskimo Whaling Commission
ASRC	Arctic Slope Regional Corporation
BOEM	Bureau of Ocean Energy Management
BOP	Blowout Preventer
CAA	Conflict Avoidance Agreement
CFR	Code of Federal Regulations
COCP	Critical Operations and Curtailment Plan
Com Centers	Communication and Call Centers
EA	Environmental Assessment
EP	Approved Camden Bay Exploration Plan
EPA	U.S. Department of Interior, Environmental Protection Agency
ft	foot/feet
ICAS	Inupiat Community of the Arctic Slope
IHAA	Incidental Harassment Authorization Application
IHA	Incidental Harassment Authorization
IMP	Ice Management Plan
in.	inch/inches
km	kilometer/kilometers
LCMF	LCMF Corporation, a division of Ukpeagvik Iñupiat Corporation
LOA	Letter of Authorization
m	meter/meters
mi	statute mile/miles
min	minutes
M/V	Motor Vessel
NMFS	National Marine Fisheries Service
NSB	North Slope Borough
NWAB	Northwest Arctic Borough
OCS	Outer Continental Shelf

ODPCP	Oil Discharge Prevention and Contingency Plan
OSR	oil spill response
POC	Plan of Cooperation
PSO	Protected species observer
SA	Subsistence Advisor
Shell	Shell Offshore Inc.
UIC	Ukpeagvik Iñupiat Corporation
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

Shell Gulf of Mexico Inc. and Shell Offshore Inc. (collectively Shell) plans to complete geophysical and geotechnical surveys (aka Open Water Marine surveys) during the 2013 open water season as distinct data acquisition programs in the Beaufort and Chukchi Seas. Shell's surveys are discussed separately in the Incidental Harassment Authorization application (IHAA), to which this Plan of Cooperation (POC) is attached as:

- Beaufort Sea and Chukchi Sea Offshore Ice Gouge Surveys; and
- Beaufort Sea and Chukchi Sea Offshore Geotechnical Surveys

Location maps that show areas proposed for geophysical and geotechnical surveys are included as Figures 1 and 2.

The vessel named herein as platform from which equipment may be deployed is not currently under contract to Shell, or a contractor to Shell. In the IHAA, Shell describes the tasks for which the support of a vessel is anticipated and, where possible, Shell may mention the name of a vessel previously contracted to perform such tasks, or other tasks. Shell has referenced the vessel simply for purposes of evaluating potential impacts from the proposed program. Proposed vessel type is discussed in Section 1.5 of the IHAA.

Ice and weather conditions will influence when and where the open water marine surveys can be conducted. But for initial planning purposes, Shell proposes that the on water portion of offshore ice gouge surveys and geotechnical surveys may be conducted within the timeframe of July through October 2013 pending mitigation measures that may temporally or spatially impact proposed surveys or investigations during this timeframe. More specific, estimated timeframes for the surveys or investigations are discussed in Section 2 of the IHAA. Not all of the activities described may be expected to result in incidental taking of marine mammals (e.g., ice gouge), but all activities and the associated vessel are discussed herein, since vessel operations in the area of requested incidental take authorization will adhere to general vessel mitigation measures (e.g., cetacean avoidance distances; see Section 3.1 of the IHAA)

BOEM Lease Sales 193, 195 and 202 Stipulation No. 5 (see Attachment A), requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas exploration activities and subsistence resources and activities. This stipulation also requires adherence to United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (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 Code of Federal Regulations [CFR] § 18.124(c)(4) and 50 CFR § 216.104(a)(12)). This POC documents meetings undertaken specifically to inform the stakeholders of the geophysical and geotechnical surveys and obtain their input.

The POC identifies the measures that Shell has developed in consultation with North Slope communities and subsistence user groups and will implement during its planned geophysical and geotechnical surveys to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell's communications and consultations with local communities concerning its geophysical and geotechnical surveys, potential conflicts with subsistence resources and hunting 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 North Slope communities, as well as the substance of its communications with subsistence stakeholder groups. Tables summarizing Shell's communications, and responses thereto, are included in Attachment B. This POC may be supplemented, as appropriate, to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements.

2.0 POC LEASE STIPULATION AND REGULATORY REQUIREMENTS

BOEM Lease Sales 193, 195 and 202 Stipulation No. 5 (in Attachment A) requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence resources and subsistence hunting activities of the residents of the North Slope. Specifically, Stipulation No. 5 requires the operator to consult directly with potentially affected North Slope subsistence communities, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC).

Consultation is needed "to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts." Stipulation No. 5 also requires the operator to document its contacts and the substance of its communications with subsistence stakeholder groups during the operator's consultation process.

The requirements of Stipulation No. 5 parallel requirements for receipt of a USFWS Letter of Authorization (LOA) and a NMFS Incidental Harassment Authorization (IHA). The LOA and IHA provide authorization for the nonlethal harassment of species protected by the Marine Mammal Protection Act. Both the USFWS and NMFS require an applicant 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)). The POC must identify the measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, both USFWS and NMFS require an applicant to communicate and consult with local subsistence communities concerning the proposed activity, 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)).

Figure 1 Location Map for Beaufort Sea Offshore Geophysical and Geotechnical Surveys

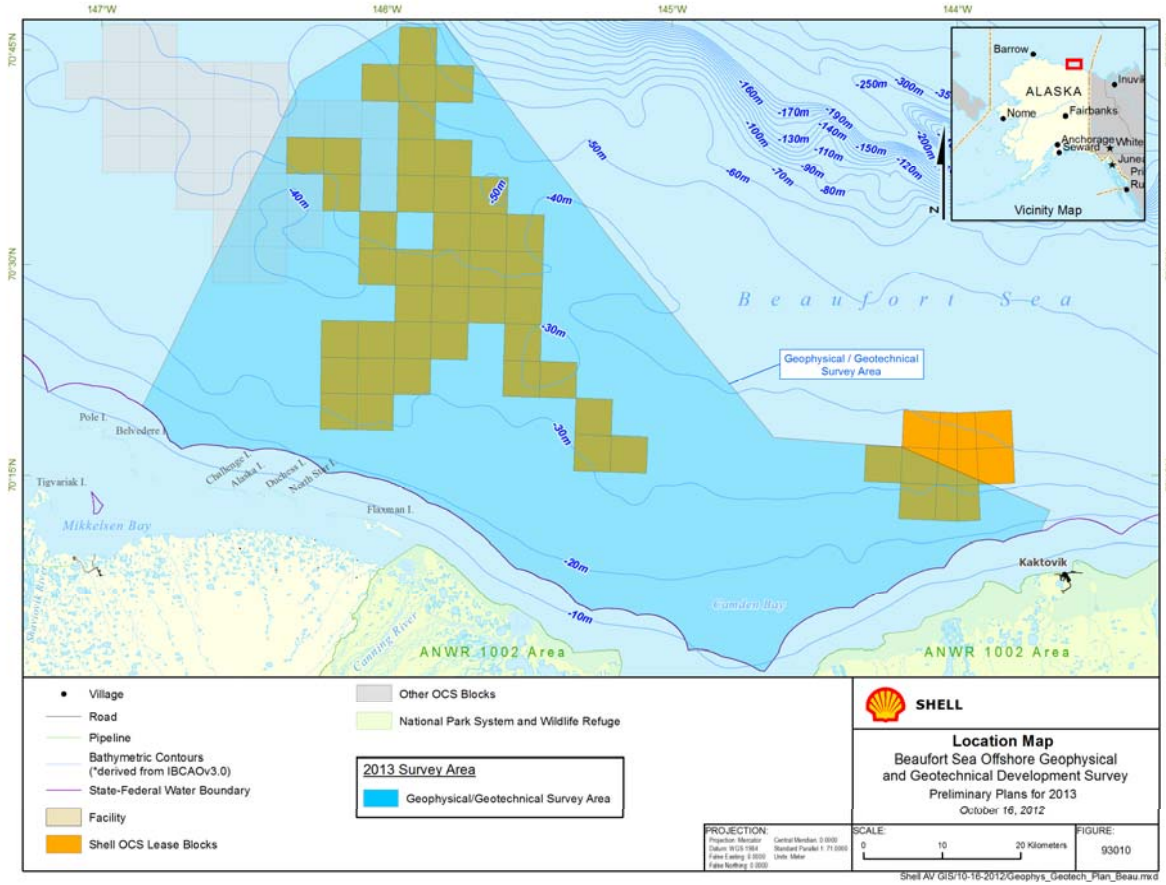
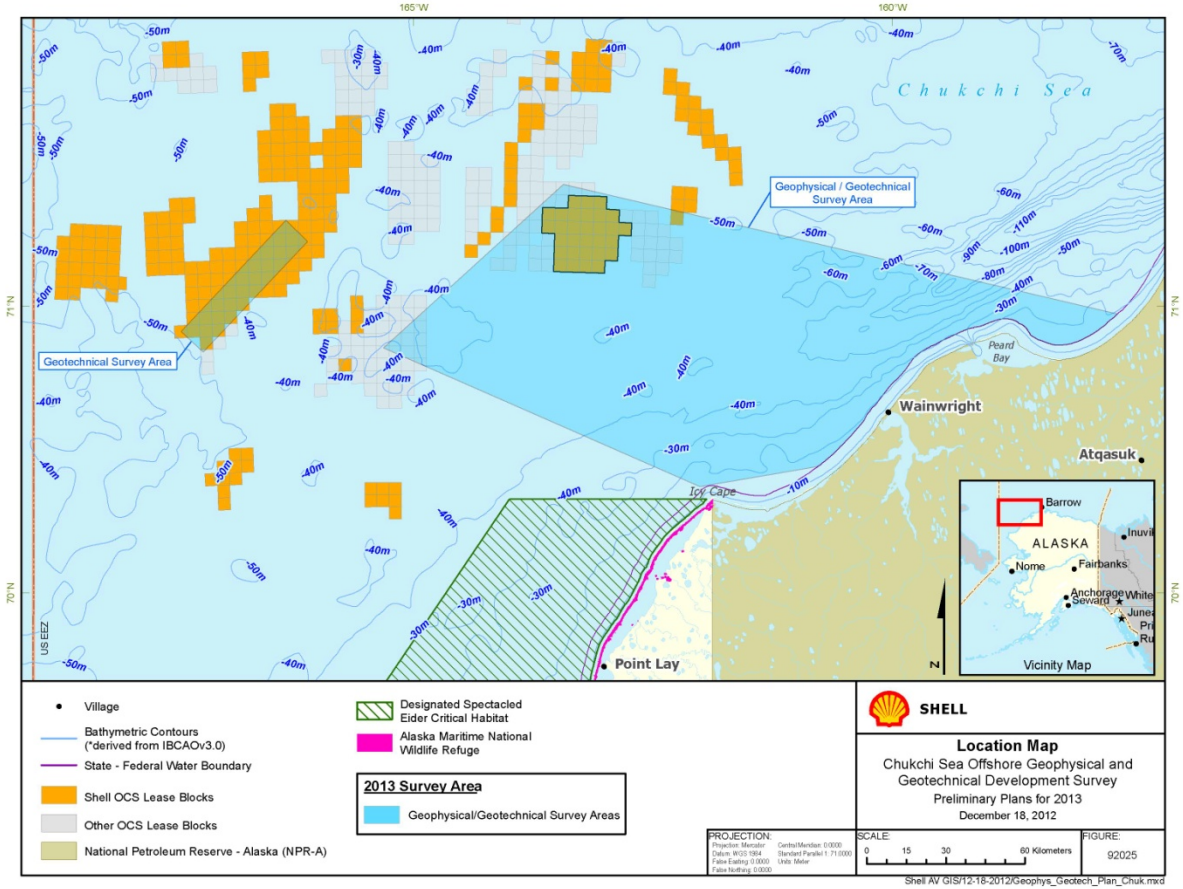


Figure 2 Location Map for Chukchi Sea Offshore Geophysical and Geotechnical Surveys



3.0 MEASURES IN PLACE

The following mitigation measures, plans and programs, are integral to this POC and were developed during consultation with potentially affected subsistence groups, communities, and the NSB. These measures, plans, and programs will be implemented by Shell during its exploration drilling operations and, as applicable, the geophysical and geotechnical surveys in both seas to monitor and mitigate potential impacts to subsistence users and resources. These measures are documented in the following sections:

- Mitigation Measures;
- Marine Mammal Monitoring and Mitigation Program (4MP); and
- Interaction and Avoidance Plan for Polar Bear and Pacific Walrus.

3.1 Geophysical and Geotechnical Surveys Mitigation Measures

The mitigation measures Shell has adopted and will implement during its geophysical and geotechnical surveys are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in Alaska since 2006 and its ongoing consultations with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. Shell's planned mitigation measures have been presented to community leaders and subsistence user groups starting in 2009 and have evolved since in response to comments and concerns expressed during the consultation process. Some mitigation measures appear under more than one sub-heading below, since they are pertinent to more than one "category" of mitigation measures.

3.1.1 Subsistence Mitigation Measures

Shell will implement the following mitigation 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.

Communication, Vessel and Aircraft Travel:

- Geophysical and geotechnical surveys in the Beaufort Sea activities are planned to begin early August depending on ice conditions will end on or before August 25th.
- During transit north to begin the surveys, Shell will notify the local communities of the transit route through the Communication and Call Centers (Com Centers).
- Vessels underway will alter course to avoid impacts to marine mammals including possible collisions, stampeding, and exclusion from access to critical resources.
- All vessels must maintain cruising speed not to exceed 9 knots while transiting the Beaufort Sea. This measure would reduce the risk of ship-whale collisions.
- Shell has developed a Communication Plan (See Attachment C) and will coordinate activities with local subsistence users as well as Village Whaling Associations in order to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Com Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell's proposed activities.
- Shell will fund the operation of Com Centers in the coastal villages to enable communications between Shell operations and vessels, local subsistence users, and Subsistence Advisors (SAs),

thereby notifying the subsistence community of any vessel transit route changes and avoiding conflicts with subsistence activities.

- Shell will employ local SAs from the Beaufort Sea and Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunt. The SAs 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 the drilling and survey season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. They will work approximately 8-hours per day and 40-hour weeks. SAs must be from a native village located on the North Slope, speak and understand Inupiaq and must have knowledge of subsistence practices for the area. After the initial recruitment and selection of potential candidates, the hiring process will consist of a two-part interview. During the first interview a full description of the job will be given including the schedule, type of work, conditions, and requirements (including drug testing, orientation, and specialized training). The second interview will assess the candidate's previous employment, subsistence hunting experience, communication skills and ensure they have good social skills. Each SA will be based out of their home village and will be given a SA handbook. The SA handbook will give an overview of the program, program objectives, discusses recruitment, hiring, and certification, and details the SA's responsibilities. The handbook will include several forms that the SA will be using along with a Traditional Knowledge Questionnaire and subsistence use maps. The handbook will provide the SA with the information needed to identify situation they are to be alert for, their responsibilities and their authorities.
- Aircraft, should any be used in support of crew changes for these surveys, shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings) 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.

3.1.2 Marine Mammal Mitigation Measures

Marine mammal mitigation measures will utilize PSOs to ensure that the geophysical and geotechnical surveys vessel activities do not disturb marine mammal resources and avoid unreasonable interference with the subsistence hunt of those resources. PSOs will be stationed on the geophysical and geotechnical surveys vessel to monitor the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. For the vessel in transit, if a marine mammal is sighted from a vessel within its respective safety radius, the vessel will reduce activity (e.g., reduce speed and/or change course) and noise level to ensure that the animal is not exposed to sound above their respective safety levels. Full activity will not be resumed until all marine mammals are outside of any relevant, regulatory exclusion zone and there are no other marine mammals likely to enter any such exclusion zone.

If anchored, the vessel will remain at anchor and continue ongoing operations if approached by a marine mammal. The anchored vessel will remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing noise conditions.

For complete PSO protocol refer to the 4MP.

In addition to the use of PSOs, Shell will implement the following measures to avoid disturbances to marine mammals that potentially could rise to the level of incidental take, and ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt.

Vessel and Aircraft Travel:

- A 4MP protocol.
- Aircraft will not operate within 1,500 ft (457 m) of whale groups.
- Aircraft and vessels will not operate within 0.5 mi (0.8 km) of walruses or polar bears when observed on water, land or ice. Due to their importance as polar bear summer resting habitat, flight paths for aircraft will be offset from the coastlines of Chukchi Sea barrier islands by at least 0.5 mile (0.8 km) and 1,500 ft above ground level. Likewise in the Beaufort Sea, flight paths for aircraft will be offset from the coastlines of Beaufort Sea barrier islands (including the Jones Island Group, Cross, Flaxman, and Tigvariak Islands) by at least 0.5 mile (800m) and 1,500 ft above ground level.
- When within 900 ft (274 m) of whales, vessels will reduce speed to no more than 5 knots, avoid separating members from a group defined as being three or more whales observed within a 1,640 ft (500 m) area displaying behaviors of directed or coordinated activity (e.g., group feeding) and avoid multiple course changes.
- Vessel speed to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.
- Aircraft shall not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, in poor weather (fog or low ceilings) 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.
- Shell will also implement non-PSO flight restrictions, should any be used in support of crew changes for these surveys, prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea. This flight will also help avoid disturbance of and collisions with birds.
- All transit will be coordinated and collaborated with Com Centers as practicable.

3.2 Marine Mammal Monitoring and Mitigation Program

Under 50 CFR 218.108, NMFS requires any holder of an IHA in Arctic waters to complete monitoring and reporting requirements established in the IHA and published regulations. Additionally, the USFWS requires all applicants for LOAs to conduct monitoring under 50 CFR 18.128. To meet these requirements, a 4MP was developed for the geophysical and geotechnical surveys. The 4MP is designed to avoid, minimize, and mitigate potential adverse impacts to marine mammal subsistence resources that may result from offshore activities. The 4MP for Shell's geophysical and geotechnical surveys activities has been sent to NMFS along with the surveys IHA application. The 4MP includes the following provisions:

- PSOs – PSOs will support the geophysical and geotechnical survey vessel while in transit and all during operations in both the Beaufort and Chukchi Seas. The shipboard PSO program is designed to provide real time observations of marine mammals by trained observers from individual vessels to document exposure to industrial activities. PSOs will be present on the geophysical and geotechnical survey vessel to monitor for the presence of marine mammals, assist maintenance of marine mammal safety radii around the vessel, monitor and record avoidance or exposure behaviors, and communicate with the Com Centers and local subsistence hunters by marine radio. The experience and abilities of the NSB residents in sighting and

identifying marine mammals during Shell's exploration programs contributed significantly to the success of Shell's previous monitoring and mitigation program.

- Acoustic Recorders – A combination of recorder technology, such as pop-up or Directional Autonomous Seafloor Acoustic Recorder buoys, to monitor wide area distribution of marine mammals, specifically bowhead whales, in relation to Shell's proposed activities.

3.3 Interaction and Avoidance Plan for Polar Bear and Pacific Walrus

Shell has prepared an interaction and avoidance plan for polar bear and Pacific walrus to meet the requirements of 50 CFR 18.128 for holders of LOAs issued by the USFWS. The plan outlines procedures for mitigating potential impacts to polar bear and Pacific walrus, as well as monitoring program requirements. Measures in the plan which cover all Shell activities are summarized here.

- New polar bear dens, identified by industry, local residents, and regulatory agencies are reported annually and will be incorporated into project plans to ensure both bear and worker safety. Bear dens discovered during operations will be reported to the designated USFWS representatives.
- Trash will be collected and separated so that all food-associated waste is placed in an appropriate bear-resistant dumpster.
- Hazardous wastes, if generated, would be transported off-site for disposal at an approved facility.
- Employees will be prohibited from directly feeding animals or deliberately leaving food for polar bears and other animals.
- If a polar bear is observed, all on-site personnel will be alerted so that work activities can be altered or stopped to avoid interactions. Personnel will contact the designated USFWS representative whenever a polar bear is sighted. Depending on the distance between the polar bear and the activities this may mean retreating to the safety of vehicles, emergency shelter, temporary buildings, or other safe haven.
- When a polar bear is observed, a designated bear watcher will be assigned to ensure continuous monitoring of the bear's movements. The On-Scene Shell Supervisor will be contacted before any bear hazing activities. Trained polar bear hazers and bear guards will support field operations.
- Vessels will observe a 0.5 mi (0.8 km) exclusion zone around any polar bear observed on water, land or ice during transit. Due to their importance as polar bear summer resting habitat, flight paths for aircraft will be offset from the coastlines of Chukchi Sea barrier islands by at least 0.5 mile (0.8 km) and 1,500 ft above ground level. Likewise in the Beaufort Sea, flight paths for aircraft will be offset from the coastlines of Beaufort Sea barrier islands (including the Jones Island Group, Cross, Flaxman, and Tigvariak Islands) by at least 0.5 mile (800m) and 1,500 ft above ground level.
- Aircraft will maintain 1,500 ft (457 m) minimum altitude within, 0.5 mi (0.8 km) of a hauled-out polar bear or Pacific walrus.
- Polar bear monitoring, reporting, and survey activities will be conducted in accordance with those outlined in 73 FR 33212 and 76 FR 47010.
- Vessels will observe a 0.5 mi (0.8 km) exclusion zone around Pacific walrus observed on water, land or ice during transit.

4.0 AFFECTED SUBSISTENCE COMMUNITY MEETINGS

Affected subsistence communities that were consulted in October and November 2012 regarding Shell's geophysical and geotechnical surveys activities include Barrow, Nuiqsut, Kaktovik, Wainwright, and Point Lay. Additionally, Shell met with the NSB Assembly.

4.1 Community Meeting Summaries

Table 4.2-1 provides a list of public meetings attended by Shell while developing this POC. Comment analysis tables for these meetings summarize feedback from the communities on Shell's planned geophysical and geotechnical survey activities. These comments analysis tables, with responses from Shell and corresponding mitigation measures pertinent to the comment are included in Attachment B. Presentation materials are also present in Attachment B.

Table 4.2-1 POC Meeting Dates and Locations

2012	Meeting Location	Meeting Attendees – Position
23 October	Point Lay	Plan of Cooperation Community Meeting
24 October	Wainwright	Plan of Cooperation Community Meeting
26 October	Kaktovik	Plan of Cooperation Community Meeting
29 October	Barrow	Plan of Cooperation Community Meeting
30 October	Nuiqsut	Plan of Cooperation Community Meeting
6 November	Barrow	NSB Assembly Workshop Meeting

4.2 Project Information and Presentation Materials

To present consistent and concise information regarding the planned geophysical and geotechnical surveys, Shell prepared presentation materials summarizing the proposed activities for 2013, including these surveys. The slides applicable to these surveys are attached in Attachment B.

4.3 Meeting Process

Prior to Shell's public meetings, meeting notices and flyers were sent to each of the communities. Announcements of Shell meetings were also transmitted by VHF radio to all the communities.

Community meetings are designed to allow the public to voice their concerns and speak one-on-one with project experts. Comment cards with a Shell return address were left with the communities and a toll free phone number and e-mail address were provided in case questions arose after the meeting. Food was provided and door prizes were given out to create a friendly environment and encourage attendance. Every effort was made to ensure the maximum amount of feedback was received and that all questions were addressed and answered to the fullest extent possible.

After each meeting, comment cards were gathered and compiled in a comment analysis table. A separate comment analysis table was completed for each POC meeting, the NSB Assembly Meeting, and each community meeting. These tables are included in Attachment B.

5.0 CONCLUSION

As discussed in Section 4, and detailed in the documents attached here, stakeholders have been provided information relevant to the project and have been invited to offer input on potential environmental, social, and health impacts, as well as and proposed mitigation and conflict avoidance measures. Shell is seeking alignment with stakeholders and, where appropriate and feasible, will incorporate the recommendations of stakeholders into project planning.

As required by applicable lease sale stipulations, as well as anticipated IHA and LOA stipulations, Shell will continue to meet with the affected subsistence communities and users to resolve any conflicts and to notify the communities of any changes in its planned operations. This POC may be supplemented, as appropriate, to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements. Shell respectfully submits that this POC meets its obligations under Stipulation No. 5, as well as the POC requirements established by applicable USFWS and NMFS regulations (50 CFR 216.104, 50 CFR 18.124 and 128).

**THIS PAGE
INTENTIONALLY
LEFT BLANK**

Attachment A
OCS Lease Sale 193, 195 and 202 Stipulations

Leasing Activities Information

MMS

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

Final
Lease Stipulations
Oil and Gas Lease Sale 193
Chukchi Sea
February 6, 2008

Stipulation 1. Protection of Biological Resources
Stipulation 2. Orientation Program
Stipulation 3. Transportation of Hydrocarbons
Stipulation 4. Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources
Stipulation 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities
Stipulation 6. Pre-Booming Requirements for Fuel Transfers
Stipulation 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities

Stipulation No. 1. Protection of Biological Resources. If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;
(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or

(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such finding to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Stipulation No. 2. Orientation Program. The lessee shall include in any exploration plan (EP) or development and production plan (DPP) submitted under 30 CFR 250.211 and 250.241 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Stipulation No. 3. Transportation of Hydrocarbons. Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any Federal, State, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the RS/FO.

Stipulation No. 4. Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources. A lessee proposing to conduct exploration operations, including ancillary seismic surveys, on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears will be required to conduct a site-specific monitoring program approved by the RS/FO, unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a minimum of 30 calendar days, but no longer than 60 calendar days, to review and comment on a proposed monitoring program prior to Minerals Management Service (MMS) approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead and beluga whales, ice seals, walruses, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on these marine mammals due to these operations. In designing the program, the lessee must consider the potential scope and extent of effects that the type of operation could have on these marine mammals. Experiences relayed by subsistence hunters indicate that, depending on the type of operations, some whales demonstrate avoidance behavior at distances of up to 35 miles. The program must also provide for the following:

(1) Recording and reporting information on sighting of the marine mammals of concern and the extent of behavioral effects due to operations;
(2) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project and other mandated aerial monitoring programs;
(3) Inviting a local representative, to be determined by consensus of the appropriate co-management organizations, to participate as an observer in the monitoring program;
(4) Submitting daily monitoring results to the RS/FO;
(5) Submitting a draft report on the results of the monitoring program to the RS/FO within 90 days following the completion of the operation. The RS/FO will distribute this draft report to the appropriate agencies and co-management organizations;
(6) Allowing 30 days for independent peer review of the draft monitoring report; and
(7) Submitting a final report on the results of the monitoring program to the RS/FO within 30 days after the completion of the independent peer review. The final report will include a discussion of the results of the peer review of the draft report. The RS/FO will distribute this report to the appropriate agencies and co-management organizations.

The RS/FO may extend the report review and submittal timelines if the RS/FO determines such an extension is warranted to accommodate extenuating circumstances.

The lessee will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for bowhead whales. The lessee may be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for other co-managed marine mammal resources. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the appropriate agencies and co-management resource organizations. The results of these peer reviews will be provided to the RS/FO for consideration in final MMS approval of the monitoring program and the final report, with copies to the appropriate agencies and co-management organizations.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from NMFS and/or FWS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. The lessee must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and must provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NMFS and/or FWS and will advise the lessee if the LOA or IHA will meet these requirements.

The MMS, NMFS, and FWS will establish procedures to coordinate results from site-specific surveys required by this stipulation and the LOA's or IHA's to determine if further modification to lease operations are necessary.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

This stipulation applies during the time periods for subsistence-harvesting described below for each community.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area. Fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walrus. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walrus can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is

unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bear are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walruses are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

This stipulation will remain in effect until termination or modification by the Department of the Interior after consultation with appropriate agencies.

Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities. Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities. This stipulation applies to exploration, development, and production operations on a lease within the blocks identified below during periods of subsistence use related to bowhead whales, beluga whales, ice seals, walruses, and polar bears. The stipulation also applies to support activities, such as vessel and aircraft traffic, that traverse the blocks listed below or Federal waters landward of the sale during periods of subsistence use regardless of lease location. Transit for human safety emergency situations shall not require adherence to this stipulation.

This stipulation applies to the following blocks:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Prior to submitting an exploration plan or development and production plan (including associated oil-spill response plans) to the MMS for activities proposed during subsistence-use critical times and locations described below for bowhead whale and other marine mammals, the lessee shall consult with the North Slope Borough, and with directly affected subsistence communities (Barrow, Point Lay, Point Hope, or Wainwright) and co-management organizations to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Organizations currently recognized by the NMFS and the FWS for the co-management of the marine mammals resources are the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other marine mammal subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The lessee shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The RS/FO shall send a copy of the exploration plan or development and production plan (including associated oil-spill response plans) to the directly affected communities and the appropriate co-management organizations at the time the plans are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, NMFS, FWS, the appropriate co-management organizations, and any communities that could be directly affected by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the parties to specifically address the conflict and attempt to resolve the issues. The RS/FO will invite appropriate parties to a meeting if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Activities on a lease may be restricted if the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts.

Subsistence-harvesting activities occur generally in the areas and time periods listed below.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area; fall whaling occurs from August to October in an area extending from approximately 10 miles west of Barrow to the east side of Dease Inlet. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walruses. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright, with whaling camps sometimes as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September, walruses can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is

unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walruses from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bears are hunted from September to April along the coast, rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walruses are harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bears primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

Stipulation No. 6. Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. The lessee's oil spill response plans must include procedures for the pre-transfer booming of the fuel barge(s).

Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities. This stipulation will minimize the likelihood that spectacled and Steller's eiders will strike drilling structures or vessels. The stipulation also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area, during times when eiders are present.

(A) General conditions: The following conditions apply to all exploration activities.

(1) An EP must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, and aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

(2) The following conditions apply to operations conducted in support of exploratory and delineation drilling.

(a) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least three *Breco* buoys or similar devices) and

personnel trained in its use; hazing equipment may located onboard the vessel or on a nearby oil spill response vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.

(b) Except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.

(c) Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level over the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, or the Ledyard Bay Critical Habitat Area between July 1 and November 15, to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

(B) Lighting Protocols. The following lighting requirements apply to activities conducted between April 15 and November 15 of each year.

(1) Drilling Structures: Lessees must adhere to lighting requirements for all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities;
- Dark paint colors for selected surfaces;
- Low-reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce

outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an EP when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

(2) Support Vessels: Surface support vessels will minimize the use of high-intensity work lights, especially when traversing the listed blocks and federal waters between the listed blocks and the coastline. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.

For the purpose of this stipulation, the listed blocks are as follows:

NR02-06, Chukchi Sea:
6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey:
6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert
6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island
6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West
6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal
6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow
6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright
6002-6006, 6052, 6053

NS04-08, (Unnamed)
6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Nothing in this stipulation is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Leasing Activities Information

MMS

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

Lease Stipulations
Oil and Gas Lease Sale 195
Beaufort Sea
March 30, 2005

Stipulation No. 1. Protection of Biological Resources
Stipulation No. 2. Orientation Program
Stipulation No. 3. Transportation of Hydrocarbons
Stipulation No. 4. Industry Site-Specific Bowhead Whale-Monitoring Program
Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities
Stipulation No. 6. Pre-Booming Requirements for Fuel Transfers
Stipulation No. 7. Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eider

Stipulation No. 1. Protection of Biological Resources. If biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;
(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such findings to the RS/FO and make every

reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Stipulation No. 2. Orientation Program. The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.203 and 250.204 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Stipulation No. 3. Transportation of Hydrocarbons. Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any advisory groups and Federal, state, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the RS/FO.

Stipulation No. 4. Industry Site-Specific Bowhead Whale-Monitoring Program. Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration will be required to conduct a site-specific monitoring program approved by the RS/FO; unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO will provide the NSB, AEWC, and the State of Alaska a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. In designing the program, lessees must consider the potential scope and extent of effects that the type of operation could have on bowhead whales. Experiences relayed by subsistence hunters indicate that, depending on the type of operations, some whales demonstrate avoidance behavior at distances of up to 35 miles. The program must also provide for the following:

(1) Recording and reporting information on sighting of other marine mammals and the extent of behavioral effects due to operations;
(2) Inviting an AEWC or NSB representative to participate in the monitoring program as an observer;
(3) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP);
(4) Submitting daily monitoring results to the MMS BWASP;
(5) Submitting a draft report on the results of the monitoring program to the RS/FO within 60 days following the completion of the operation (the RS/FO will distribute this draft report to the AEWC, the NSB, the State of Alaska, and the National Oceanic and Atmospheric Administration-Fisheries [NOAA]); and
(6) Submitting a final report on the results of the monitoring program to the RS/FO (the final report will include a discussion of the results of the peer review of the draft report and the RS/FO will distribute this report to the AEWC, the NSB, the State of Alaska, and the NOAA Fisheries).

Lessees will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the NSB, the AEWC, industry, NOAA Fisheries, and MMS. The results of these peer reviews will be provided to the RS/FO for consideration in final approval of the monitoring program and the final report, with copies to the NSB, AEWC, and the State of Alaska.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from the NOAA Fisheries, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation.

Lessees must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NOAA Fisheries and advise the lessee if the LOA or IHA will meet these requirements.

This stipulation applies to the following blocks for the time periods listed and will remain in effect until termination or modification by the Department of the Interior, after consultation with the NOAA Fisheries and the NSB.

Spring Migration Area: April 1 through June 15

OPD: NR 05-01, Dease Inlet. Blocks included:

6102-6111	6302-6321	6508-6523	6717-6723
6152-6167	6354-6371	6560-6573	
6202-6220	6404-6423	6610-6623	
6252-6270	6455-6473	6659-6673	

OPD: NR 05-02, Harrison Bay North: Blocks included:

6401-6404	6501-6506	6601-6609	6701-6716
6451-6454	6551-6556	6651-6659	

Central Fall Migration Area: September 1 through October 31

OPD: NR 05-01, Dease Inlet. Blocks included:

6102-6111	6354-6371	6610-6623	6856-6873
6152-6167	6404-6423	6659-6673	6908-6923
6202-6220	6455-6473	6706-6723	6960-6973
6252-6270	6508-6523	6756-6773	7011-7023
6302-6321	6560-6573	6806-6823	7062-7073
			7112-7123

OPD: NR 05-02, Harrison Bay North. Blocks included:

6401-6404	6601-6609	6801-6818	7001-7023
6451-6454	6651-6659	6851-6868	7051-7073
6501-6506	6701-6716	6901-6923	7101-7123
6551-6556	6751-6766	6951-6973	

OPD: NR 05-03, Teshekpuk. Blocks included:

6015-6024	6067-6072

OPD: NR 05-04, Harrison Bay. Blocks included:

6001-6023	6157-6173	6309-6324	6461-6471
6052-6073	6208-6223	6360-6374	6513-6519
6106-6123	6258-6274	6410-6424	6565-6566

OPD: NR 06-01, Beechey Point North. Blocks included:

6901-6911	6951-6962	7001-7012	7051-7062
			7101-7113

OPD: NR 06-03, Beechey Point. Blocks included:

6002-6014	6202-6220	6401-6424	6618-6624
6052-6064	6251-6274	6456-6474	6671-6674
6102-6114	6301-6324	6509-6524	6722-6724
6152-6169	6351-6374	6568-6574	6773

OPD: NR 06-04, Flaxman Island. Blocks included:

6301-6303	6451-6459	6601-6609	6751-6759
6351-6359	6501-6509	6651-6659	6802-6809
6401-6409	6551-6559	6701-6709	6856-6859

Eastern Fall Migration: August 1 through October 31

OPD: NR 06-04, Flaxman Island. Blocks included:

6360-6364	6560-6574	6760-6774	6961-6974
6410-6424	6610-6624	6810-6824	7013-7022
6460-6474	6660-6674	6860-6874	7066-7070
6510-6524	6710-6724	6910-6924	7118-7119

OPD: NR 07-03, Barter Island. Blocks included:

6401-6405	6601-6605	6801-6803	7012-7013
6451-6455	6651-6655	6851-6853	7062-7067
6501-6505	6701-6705	6901-6903	7113-7117
6551-6555	6751-6753	6962-6963	

OPD: NR 07-05, Demarcation Point. Blocks included:

6016-6022	6118-6125	6221-6226	6324-6326
6067-6072	6169-6175	6273-6276	

OPD: NR 07-06, Mackenzie Canyon. Blocks included:

6201	6251	6301	6351

***Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities*.** Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).

Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the directly affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) to discuss potential conflicts with the siting, timing, and methods of

proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Lessees shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The RS/FO shall send a copy of the exploration plan or development and production plan (including associated oil-spill contingency plans) to the directly affected communities and the AEWC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Oceanic and Atmospheric Administration - Fisheries (NOAA), or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NOAA Fisheries, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Lease-related use will be restricted when the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts.

Subsistence whaling activities occur generally during the following periods:

August to October: Kaktovik whalers use the area circumscribed from Anderson Point in Camden Bay to a point 30 kilometers north of Barter Island to Humphrey Point east of Barter Island. Nuiqsut whalers use an area extending from a line northward of the Nechelik Channel of the Colville River to Flaxman Island, seaward of the Barrier Islands.

September to October: Barrow hunters use the area circumscribed by a western boundary extending approximately 15 kilometers west of Barrow, a northern boundary 50 kilometers

north of Barrow, then southeastward to a point about 50 kilometers off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Cape Halkett.

Stipulation No. 6 - Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring 3 weeks prior to or during the bowhead whale migration will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. This stipulation is applicable to the blocks and migration times listed in the stipulation on Industry Site-Specific Bowhead Whale-Monitoring. The lessee's oil-spill-contingency plans must include procedures for the pre-transfer booming of the fuel barge(s).

Stipulation No. 7. Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eider. In accordance with the Biological Opinion for the Beaufort Sea Lease Sale 186 issued by the U.S. Fish and Wildlife Service (FWS) on October 22, 2002, and FWS's subsequent amendment of the Incidental Take Statement on September 21, 2004, lessees must adhere to lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating spectacled or Steller's eiders will strike these structures.

Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that spectacled or Steller's eiders will strike those structures. These requirements establish a coordinated process for a performance based objective rather than pre-determined prescriptive requirements. The performance based objective is to minimize the radiation of light outward from exploration/delineation structures. Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities.
- Dark paint colors for selected surfaces;
- Low reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches to reduce outward light radiation that could be applied to their specific facility and operation.

If further information on bird avoidance measures becomes available that suggests modification to this lighting protocol is warranted under the Endangered Species Act to implement the reasonable and prudent measures of the Biological Opinion, MMS will issue further requirements, based on guidance from the FWS. Lessees will be required to adhere to such modifications of this protocol. The MMS will promptly notify lessees of any changes to lighting required under this stipulation.

These requirements apply to all new and existing Outer Continental Shelf oil and gas leases issued between the 156^0 W longitude and 146^0 W longitude for activities conducted between May 1 and October 31. The MMS encourages operators to consider such measures in areas to the east of 146^0 W longitude because occasional sightings of eiders that are now listed have been made there and because such measures could reduce the potential for collisions of other, non-ESA listed migratory birds that are protected under the Migratory Bird Treaty Act.

Nothing in this protocol is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g. U.S. Coast Guard or Department of Occupational Safety and Health) for marking or lighting of equipment and work areas.

Lessees are required to report spectacled and/or Steller's eiders injured or killed through collisions with lease structures to the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska at (907) 456-0499. We recommend that you call that office for instruction on the handling and disposal of the injured or dead bird.

Lessees must provide MMS with a written statement of measures that will be or that have been taken to meet the objective of this stipulation. Lessees must also include a plan for recording and reporting bird strikes that occur during approved activities to the MMS. This information must be included with an Exploration Plan when the EP is submitted for regulatory review and approval pursuant to 30 CFR 250.203. Lessees are encouraged to discuss their proposed measures in a pre-submittal meeting with the MMS and FWS.

Leasing Activities Information

MMS

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

Lease Stipulations

Oil and Gas Lease Sale 202
Beaufort Sea
April 18, 2007

Stipulation No. 1. Protection of Biological Resources
Stipulation No. 2. Orientation Program
Stipulation No. 3. Transportation of Hydrocarbons
Stipulation No. 4. Industry Site-Specific Bowhead Whale-Monitoring Program
Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities
Stipulation No. 6. Pre-Booming Requirements for Fuel Transfers
Stipulation No. 7. Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eider

Stipulation No. 1. Protection of Biological Resources. If biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;
(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such findings to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Stipulation No. 2. Orientation Program. The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.201 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Stipulation No. 3. Transportation of Hydrocarbons. Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any advisory groups and Federal, state, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the RS/FO.

Stipulation No. 4. Industry Site-Specific Bowhead Whale-Monitoring Program. Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration will be required to conduct a site-specific monitoring program approved by the RS/FO; unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO will provide the NSB, AEWC, and the State of Alaska a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. In designing the program, lessees must consider the potential scope and extent of effects that the type of operation could have on bowhead whales. Experiences relayed by subsistence hunters indicate that, depending on the type of operations, some whales demonstrate avoidance behavior at distances of up to 35 miles. The program must also provide for the following:

(1) Recording and reporting information on sighting of other marine mammals and the extent of behavioral effects due to operations;
(2) Inviting an AEWC or NSB representative to participate in the monitoring program as an observer;
(3) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP);
(4) Submitting daily monitoring results to the MMS BWASP;
(5) Submitting a draft report on the results of the monitoring program to the RS/FO within 60 days following the completion of the operation (the RS/FO will distribute this draft report to the AEWC, the NSB, the State of Alaska, and the National Oceanic and Atmospheric Administration-Fisheries [NOAA]); and
(6) Submitting a final report on the results of the monitoring program to the RS/FO (the final report will include a discussion of the results of the peer review of the draft report and the RS/FO will distribute this report to the AEWC, the NSB, the State of Alaska, and the NOAA Fisheries).

Lessees will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the NSB, the AEWC, industry, NOAA Fisheries, and MMS. The results of

these peer reviews will be provided to the RS/FO for consideration in final approval of the monitoring program and the final report, with copies to the NSB, AEWC, and the State of Alaska.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from the NOAA Fisheries, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. Lessees must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NOAA Fisheries and advise the lessee if the LOA or IHA will meet these requirements.

This stipulation applies to the following blocks for the time periods listed and will remain in effect until termination or modification by the Department of the Interior, after consultation with the NOAA Fisheries and the NSB.

Spring Migration Area: April 1 through June 15

OPD: NR 05-01, Dease Inlet. Blocks included:

6102-6111	6302-6321	6508-6523	6717-6723
6152-6167	6354-6371	6560-6573	
6202-6220	6404-6423	6610-6623	
6252-6270	6455-6473	6659-6673	

OPD: NR 05-02, Harrison Bay North: Blocks included:

6401-6404	6501-6506	6601-6609	6701-6716
6451-6454	6551-6556	6651-6659	

Central Fall Migration Area: September 1 through October 31

OPD: NR 05-01, Dease Inlet. Blocks included:

6102-6111	6354-6371	6610-6623	6856-6873
6152-6167	6404-6423	6659-6673	6908-6923
6202-6220	6455-6473	6706-6723	6960-6973
6252-6270	6508-6523	6756-6773	7011-7023
6302-6321	6560-6573	6806-6823	7062-7073
			7112-7123

OPD: NR 05-02, Harrison Bay North. Blocks included:

6401-6404	6601-6609	6801-6818	7001-7023
6451-6454	6651-6659	6851-6868	7051-7073
6501-6506	6701-6716	6901-6923	7101-7123
6551-6556	6751-6766	6951-6973	

OPD: NR 05-03, Teshekpuk. Blocks included:

6015-6024	6067-6072

OPD: NR 05-04, Harrison Bay. Blocks included:

6001-6023	6157-6173	6309-6324	6461-6471
6052-6073	6208-6223	6360-6374	6513-6519
6106-6123	6258-6274	6410-6424	6565-6566

OPD: NR 06-01, Beechey Point North. Blocks included:

6901-6911	6951-6962	7001-7012	7051-7062
			7101-7113

OPD: NR 06-03, Beechey Point. Blocks included:

6002-6014	6202-6220	6401-6424	6618-6624
6052-6064	6251-6274	6456-6474	6671-6674
6102-6114	6301-6324	6509-6524	6722-6724
6152-6169	6351-6374	6568-6574	6773

OPD: NR 06-04, Flaxman Island. Blocks included:

6301-6303	6451-6459	6601-6609	6751-6759
6351-6359	6501-6509	6651-6659	6802-6809
6401-6409	6551-6559	6701-6709	6856-6859

<u>Eastern Fall Migration: August 1 through October 31</u>

OPD: NR 06-04, Flaxman Island. Blocks included:

6360-6364	6560-6574	6760-6774	6961-6974
6410-6424	6610-6624	6810-6824	7013-7022
6460-6474	6660-6674	6860-6874	7066-7070
6510-6524	6710-6724	6910-6924	7118-7119

OPD: NR 07-03, Barter Island. Blocks included:

6401-6405	6601-6605	6801-6803	7012-7013
6451-6455	6651-6655	6851-6853	7062-7067
6501-6505	6701-6705	6901-6903	7113-7117
6551-6555	6751-6753	6962-6963	

OPD: NR 07-05, Demarcation Point. Blocks included:

6016-6022	6118-6125	6221-6226	6324-6326
6067-6072	6169-6175	6273-6276	

OPD: NR 07-06, Mackenzie Canyon. Blocks included:

6201	6251	6301	6351

Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities. Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).

Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the directly affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Lessees shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The RS/FO shall send a copy of the exploration plan or development and production plan (including associated oil-spill contingency plans) to the directly affected communities and the AEWC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Oceanic and Atmospheric Administration - Fisheries (NOAA), or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NOAA Fisheries, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. Lease-related use will be restricted when the RS/FO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting activities.

In enforcing this stipulation, the RS/FO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts.

Subsistence whaling activities occur generally during the following periods:

August to October: Kaktovik whalers use the area circumscribed from Anderson Point in Camden Bay to a point 30 kilometers north of Barter Island to Humphrey Point east of Barter Island. Nuiqsut whalers use an area extending from a line northward of the Nechelik Channel of the Colville River to Flaxman Island, seaward of the Barrier Islands.

September to October: Barrow hunters use the area circumscribed by a western boundary extending approximately 15 kilometers west of Barrow, a northern boundary 50 kilometers north of Barrow, then southeastward to a point about 50 kilometers off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Cape Halkett.

Stipulation No. 6 - Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring 3 weeks prior to or during the bowhead whale migration will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. This stipulation is applicable to the blocks and migration times listed in the stipulation on Industry Site-Specific Bowhead Whale-Monitoring. The lessee's oil-spill-contingency plans must include procedures for the pre-transfer booming of the fuel barge(s).

Stipulation No. 7. Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eider. In accordance with the Biological Opinion for the Beaufort Sea Lease Sale 186 issued by the U.S. Fish and Wildlife Service (FWS) on October 22, 2002, and FWS's subsequent amendment of the Incidental Take Statement on September 21, 2004, lessees must adhere to lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating spectacled or Steller's eiders will strike these structures.

Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that spectacled or Steller's eiders will strike those structures. These requirements establish a coordinated process for a performance based objective rather than pre-determined prescriptive requirements. The performance based objective is to minimize the radiation of light outward from exploration/delineation structures. Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities.
- Dark paint colors for selected surfaces;

- Low reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches to reduce outward light radiation that could be applied to their specific facility and operation.

If further information on bird avoidance measures becomes available that suggests modification to this lighting protocol is warranted under the Endangered Species Act to implement the reasonable and prudent measures of the Biological Opinion, MMS will issue further requirements, based on guidance from the FWS. Lessees will be required to adhere to such modifications of this protocol. The MMS will promptly notify lessees of any changes to lighting required under this stipulation.

These requirements apply to all new and existing Outer Continental Shelf oil and gas leases issued between the 156^0 W longitude and 146^0 W longitude for activities conducted between May 1 and October 31. The MMS encourages operators to consider such measures in areas to the east of 146^0 W longitude because occasional sightings of eiders that are now listed have been made there and because such measures could reduce the potential for collisions of other, non-ESA listed migratory birds that are protected under the Migratory Bird Treaty Act.

Nothing in this protocol is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g. U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Lessees are required to report spectacled and/or Steller's eiders injured or killed through collisions with lease structures to the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska at (907) 456-0499. We recommend that you call that office for instruction on the handling and disposal of the injured or dead bird.

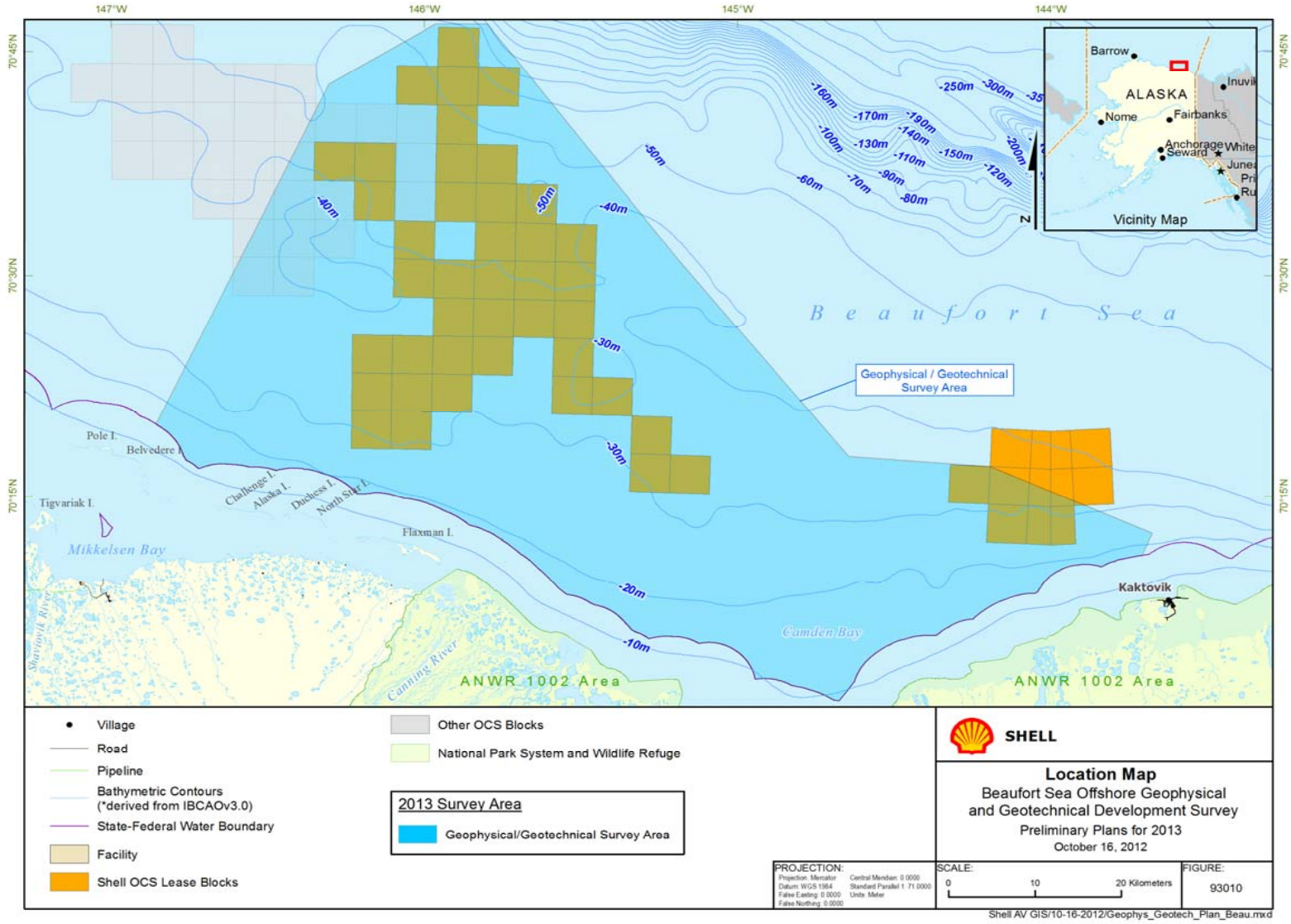
Lessees must provide MMS with a written statement of measures that will be or that have been taken to meet the objective of this stipulation. Lessees must also include a plan for recording and reporting bird strikes that occur during approved activities to the MMS. This information must be included with an Exploration Plan when the EP is submitted for regulatory review and approval pursuant to 30 CFR 250.201. Lessees are encouraged to discuss their proposed measures in a pre-submittal meeting with the MMS and FWS.

**THIS PAGE
INTENTIONALLY
LEFT BLANK**

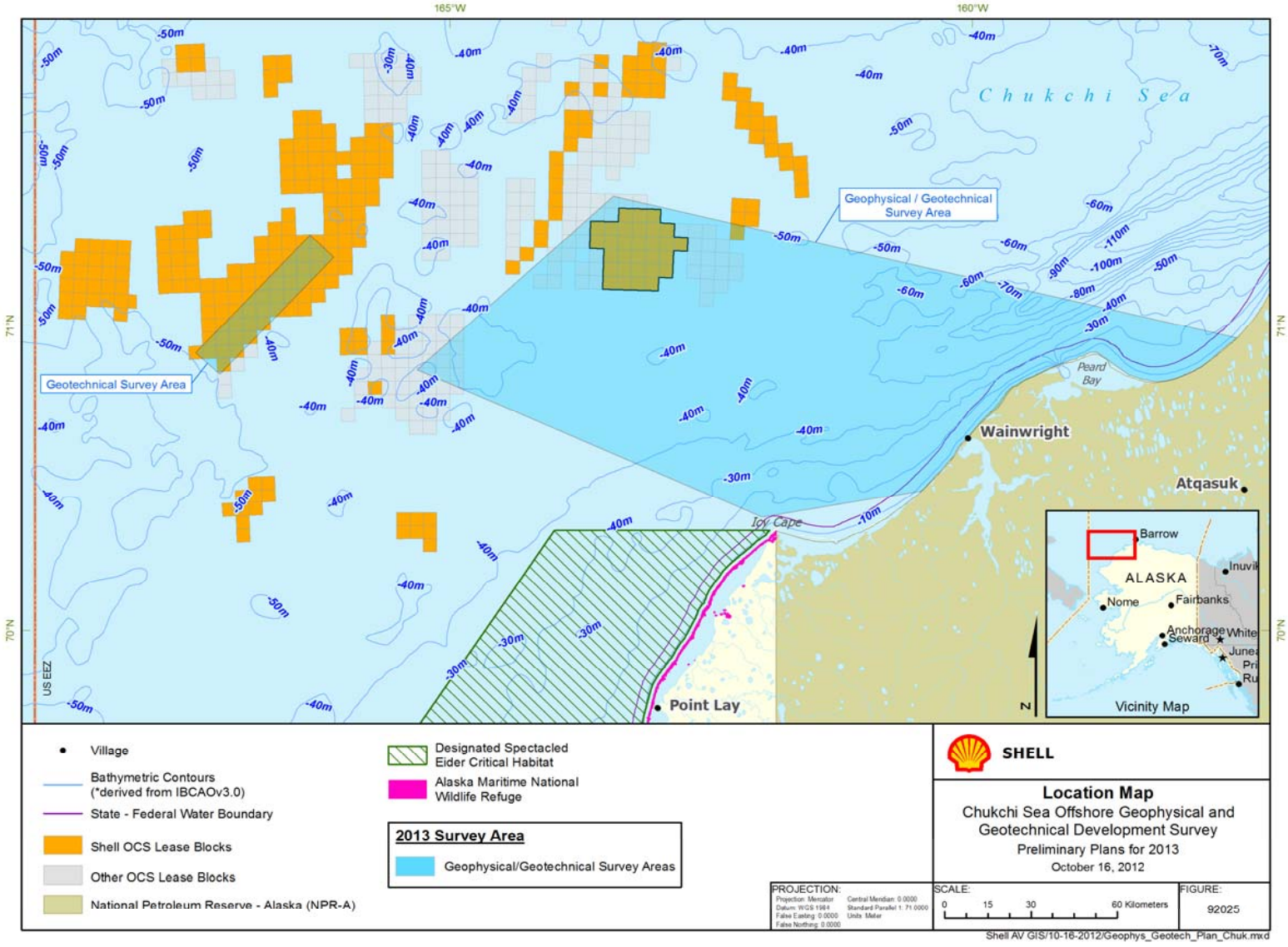
Attachment B
Communication and Consultation with North Slope Subsistence Stakeholders: Community Meeting Comments and Responses and Presentation

2013 DEVELOPMENT SURVEYS OFFSHORE

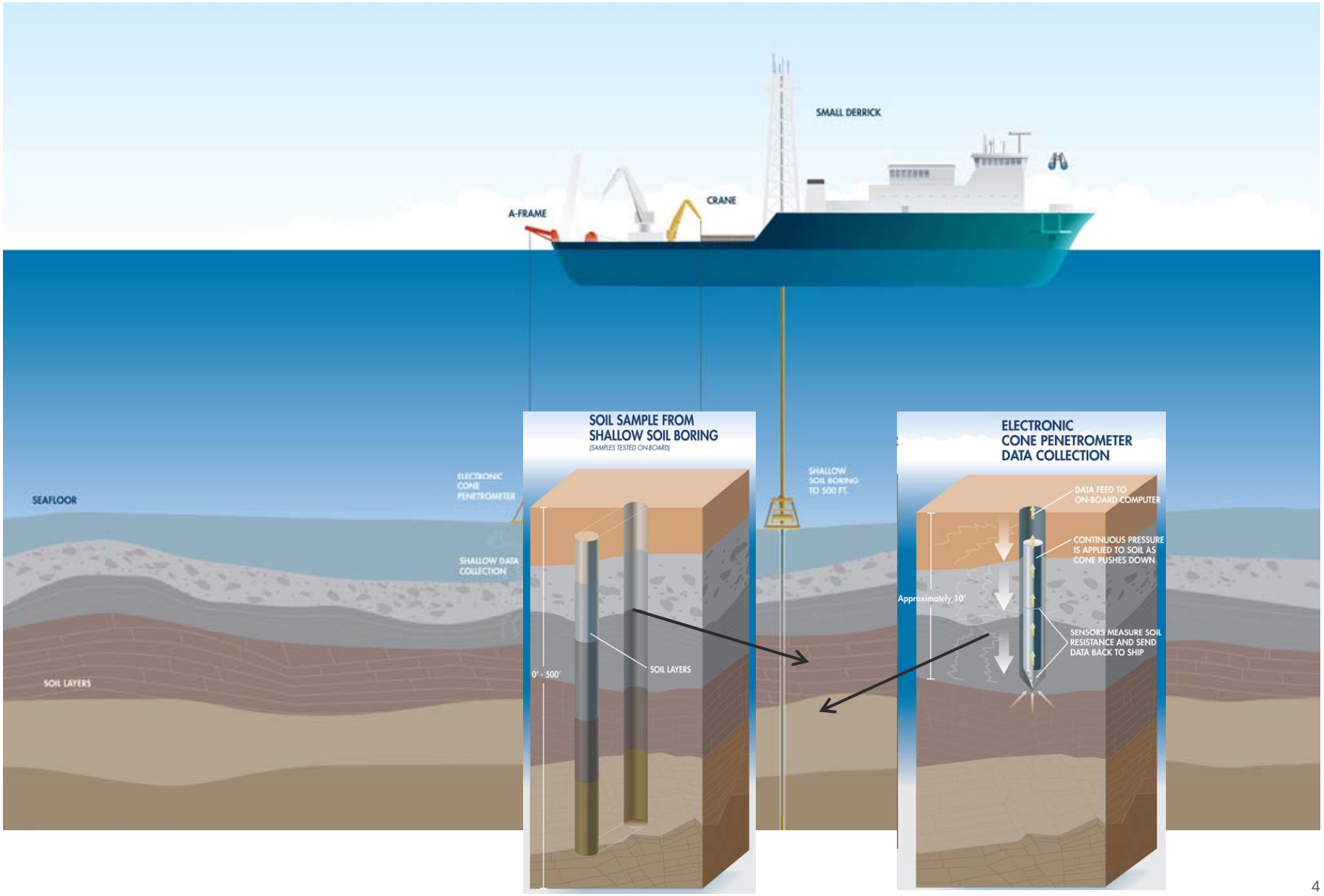
Beaufort Geotechnical & Ice Gouge Survey Area



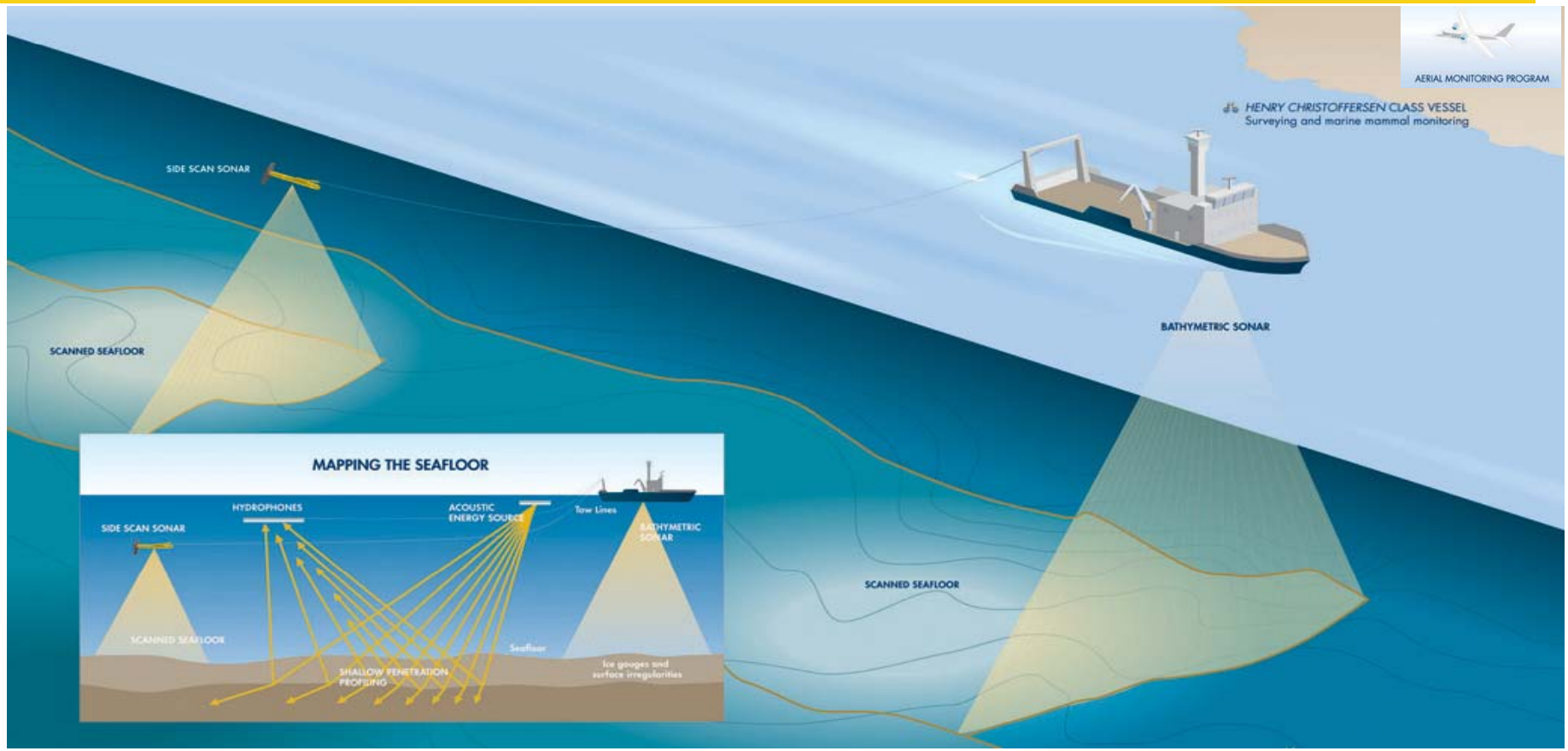
Chukchi Sea Geotechnical & Ice Gouge Survey Area

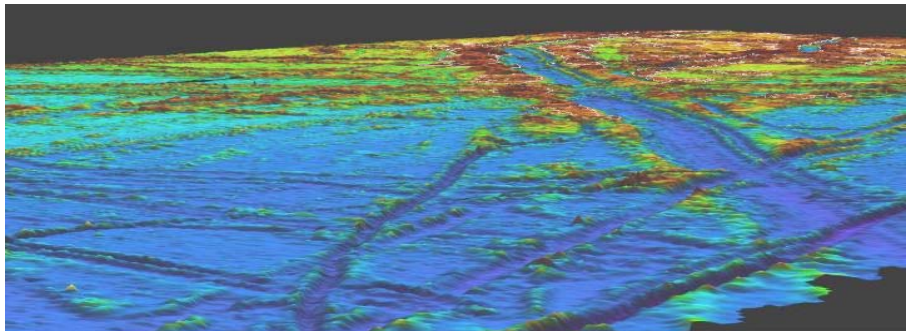


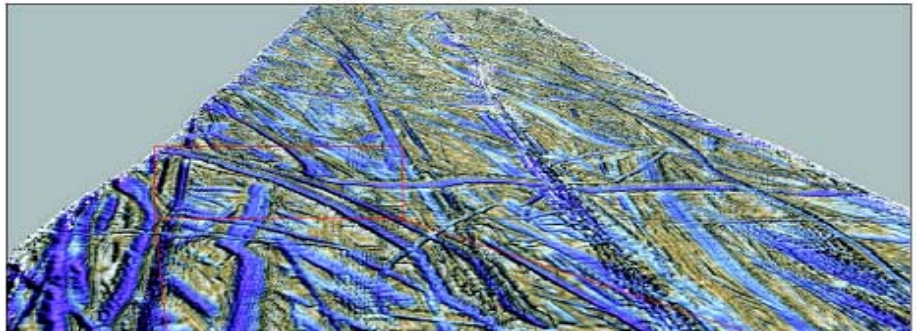
2013 Geotechnical Survey Activities



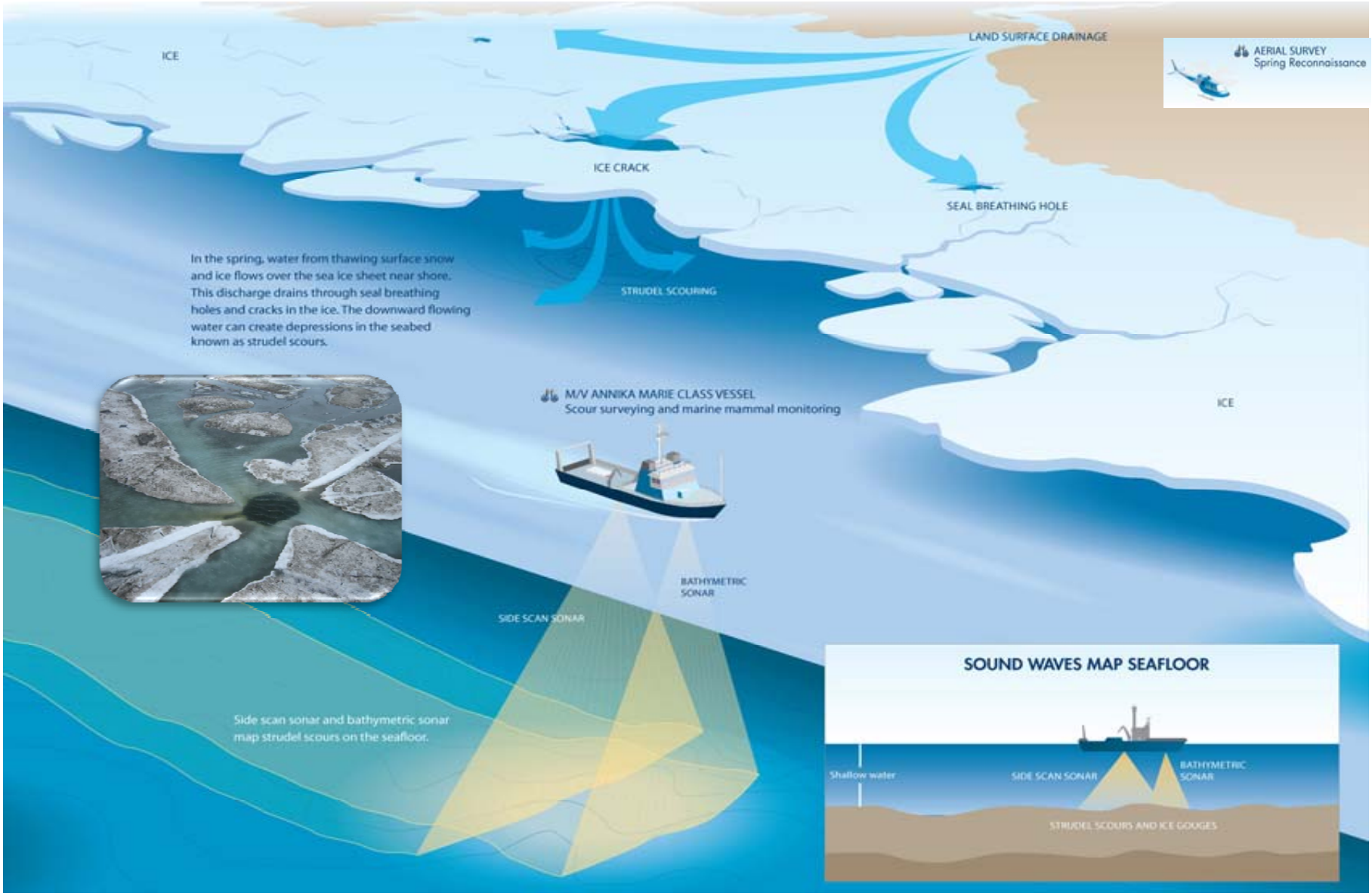
2013 Ice Gouge Survey Activities







2013 Strudel Scour Activities



Issues	Comments	Shell Response	Mitigation Measures*
Marine Surveys – Geotechnical Drilling	What is the depth of the water in the Chukchi Sea in development areas?	about 150-180 feet of water	N/A
Marine Surveys – Geotechnical Drilling	How many leases are in the Cracker Jack area?	There are 30 leases but we are only doing Geotech in that area.	N/A
Marine Surveys – Geotechnical Drilling	What is the probability of a discovery in the Cracker Jack area?	There was an exploration well that did not penetrate hydrocarbons so we are hoping to drill a well that does penetrate hydrocarbons.	N/A

Notes:

*Mitigation Measures are only assigned to applicable comments.
"Not applicable" (N/A) is used to designate comments that do not require mitigation measures as a course of action. See Mitigation Measures Index definitions according to assigned letter.

2012 Proposed Mitigation Measures

A-Communication Plan for avoiding conflicts with subsistence users.
B-Collaboration and Communication with Whaling Associations
C-Plan of Cooperation (will work to obtain a CAA)
D-Will honor 2010 Camden blackout dates for Nuiqsut and Kaktovik whaling.
E-Subsistence Advisors based in Chukchi and Beaufort Sea Villages and Kotzebue
F-Marine Mammal Observers
G-Robust Marine Mammal Monitoring Protocol
H-OSR Fleet on standby 24/7 near drilling location
I-Real time Ice and Weather Forecasting
J-Crew change by helicopter and collaboration on routes to and from shore base
K-zero discharge of: drilling fluids and cuttings after the 26-in casing; gray and treated black waters; bilge and ballast waters
L-enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, prefabricated subsea collection and containment system, and relief well plan with designated standby relief well drilling unit).

Issues	Comments	Shell Response	Mitigation Measures*
Marine Surveys – Geotechnical Drilling	How deep will the Geotech wells be?	A few hundred feet.	N/A
Marine Surveys – Geotechnical Drilling	What if you strike natural gas or something? How do you know it's not that deep?	We've done shallow hazard surveys down to several thousand feet, so we know what is down there and can avoid areas of shallow natural gas.	N/A
Marine Surveys – Strudel Scour	So you've done the seismic surveys of ice gouging in the past, so why are you doing it again?	We want to see if anything has left new gouges in the past 10 years to see what new gouges are there. (In response to another comment that was not noted, it was mentioned ice gouges can be deep and potentially damage an exploration well structure near the seabed. If the top of a well is damaged, the wells are plugged deep down, so there is no chance of there being a problem with ice gouging.)	N/A

Notes:

*Mitigation Measures are only assigned to applicable comments.
"Not applicable" (N/A) is used to designate comments that do not require mitigation measures as a course of action. See Mitigation Measures Index definitions according to assigned letter.

2012 Proposed Mitigation Measures

A-Communication Plan for avoiding conflicts with subsistence users.
B-Collaboration and Communication with Whaling Associations
C-Plan of Cooperation (will work to obtain a CAA)
D-Will honor 2010 Camden blackout dates for Nuiqsut and Kaktovik whaling.
E-Subsistence Advisors based in Chukchi and Beaufort Sea Villages and Kotzebue
F-Marine Mammal Observers
G-Robust Marine Mammal Monitoring Protocol
H-OSR Fleet on standby 24/7 near drilling location
I-Real time Ice and Weather Forecasting
J-Crew change by helicopter and collaboration on routes to and from shore base
K-zero discharge of: drilling fluids and cuttings after the 26-in casing; gray and treated black waters; bilge and ballast waters
L-enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, prefabricated subsea collection and containment system, and relief well plan with designated standby relief well drilling unit).

Issues	Comments	Shell Response	Mitigation Measures*
Marine Program	When are going to start the geotechnical borings?	July 2013.	N/A
Marine Program	What vessel is this on the slide?	This is a cartoon rendering not a specific vessel	N/A

Notes:

*Mitigation Measures are only assigned to applicable comments.
"Not applicable" (N/A) is used to designate comments that do not require mitigation measures as a course of action. See Mitigation Measures Index definitions according to assigned letter.

2012 Proposed Mitigation Measures

A-Communication Plan for avoiding conflicts with subsistence users.
B-Collaboration and Communication with Whaling Associations
C-Plan of Cooperation (will work to obtain a CAA)
D-Will honor 2010 Camden blackout dates for Nuiqsut and Kaktovik whaling.
E-Subsistence Advisors based in Chukchi and Beaufort Sea Villages and Kotzebue
F-Marine Mammal Observers
G-Robust Marine Mammal Monitoring Protocol
H-OSR Fleet on standby 24/7 near drilling location
I-Real time Ice and Weather Forecasting
J-Crew change by helicopter and collaboration on routes to and from shore base
K-zero discharge of: drilling fluids and cuttings after the 26-in casing; gray and treated black waters; bilge and ballast waters
L-enhanced blowout prevention and mitigation measures (i.e., second set of blind shear rams, increased frequency of BOP testing, redundant ROV hot stab panel, prefabricated subsea collection and containment system, and relief well plan with designated standby relief well drilling unit).

**THIS PAGE
INTENTIONALLY
LEFT BLANK**

Attachment C
Communication Plan

COMMUNICATION PLAN
2013 OPEN WATER MARINE SURVEYS CHUKCHI and BEAUFORT SEAS, ALASKA

The following Communication Plan will be used during the 2013 geophysical and geotechnical marine surveys program, (aka Open Water Marine Surveys Program; ice gouge survey; geotechnical survey) in the Chukchi and Beaufort Seas to coordinate activities with local subsistence users. These users include the Alaska Eskimo Whaling Commission (AEWC), Alaska Eskimo Walrus Commission (AWC), Alaska Nanuuq Commission (ANC), Alaska Beluga Whale Committee (ABWC), Ice Sea Committee (ICS), village Whaling Captains Associations (WCA), and industry representatives. The planned Program is anticipated to continue from July through October.

The Communications Plan will be implemented in two phases. Phase I describes the guidelines already in place to ensure proper communication during the Program. Phase II describes what to do in the event Shell activities potentially affect subsistence activities and how to keep subsistence user groups informed of Shell activities. Phase I and II are designed to minimize the potential for interference of Shell activities with subsistence activities and resources and to keep operators up-to-date regarding the timing and status of the bowhead whale migration as well as the timing and status of other subsistence hunts.

Program operations will be performed in compliance with all applicable permits and authorizations, including:

- Plan of Cooperation (U.S. Fish & Wildlife Service (USFWS); National Marine Fisheries Service (NMFS) and Bureau of Ocean Energy Management (BOEM);
- Letter of Authorization per USFWS;
- Incidental Harassment Authorization per NMFS;
- Ancillary Activity Authorization per BOEM;
- Lease Stipulation 5 from Outer Continental Shelf lease sales 193, 195 and 202 per BOEM;

PHASE I

- Protected Species Observers (PSOs) will be onboard the geophysical and geotechnical survey vessel with responsibilities to: monitor for the presence of marine mammals; assist with the maintenance of marine mammal safety radii around vessels; monitor and record avoidance or exposure behaviors; and communicate with the Communication and Call Centers (Com Centers) and local subsistence hunters by marine radio.
- If a conflict arises between Program activities and subsistence hunting, the PSOs will immediately contact the vessel captain and the Com Centers. The Com Centers will then contact Shell's simultaneous operations response team. If avoidance is not possible, the next phase will include communication between a Shell representative and a

representative from the impacted subsistence hunter group(s) to resolve the issue and plan an alternative course of action by either industry or the subsistence groups.

- Shell will employ local Subsistence Advisors from the Chukchi Sea and Beaufort Sea villages to provide consultation and guidance regarding the affected species migration, the subsistence hunt, and other subsistence activities. The Subsistence Advisors will work approximately 8-hours per day and 40-hour weeks through 2013. Responsibilities of the Subsistence Advisors will include: reporting any subsistence concerns or conflicts, within 4-hours if the conflict appears imminent, to the Com Centers (who will then contact Shell's simultaneous operations emergency response team); coordinating with subsistence users to advise on location and timing of Shell's activities; reporting subsistence-related comments, concerns, and information to Shell staff; and, advising Shell how to avoid subsistence conflicts and subsistence users. A subsistence advisor handbook will be developed and provided to each Subsistence Advisor. The handbook will outline contact numbers, communication procedures, and communication timelines for reporting and communicating potential conflict situations.
- Aircraft traffic flight restrictions will be in place to prohibit aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude, (except during takeoffs and landings, or in emergency situations), while over land or sea. If flights need to deviate from this path due to emergency landings or other unavoidable reasons, the new flight information will be immediately shared, as outlined by Shell HSSE requirements, with Com Centers so area subsistence users can be notified.
- To minimize impacts on marine mammals and subsistence hunting activities, the marine surveys vessel will transit through the Chukchi and Beaufort Seas along a route that allows for the highest degree of safety regarding ice conditions and sea states.

PHASE II

All guidelines in Phase I will be adhered to in addition to the following:

- If potential conflicts are identified between Shell activities and subsistence activities; the Communications Plan will be used to manage the issue.
- Once transiting of the vessel begins through Chukchi and Beaufort Seas, during marine surveys activities, and during mobilization from the Chukchi and Beaufort Seas, depending on the pending routes and timing of transit, Shell will continue with engagements and regular communications with the AEWC, AWC, ANC, ABWC, ISC, and/or the WCAs of Barrow, Wainwright, Point Lay, Point Hope, Nuiqsut and Kaktovik.

**THIS PAGE
INTENTIONALLY
LEFT BLANK**

THIS PAGE
INTENTIONALLY
LEFT BLANK