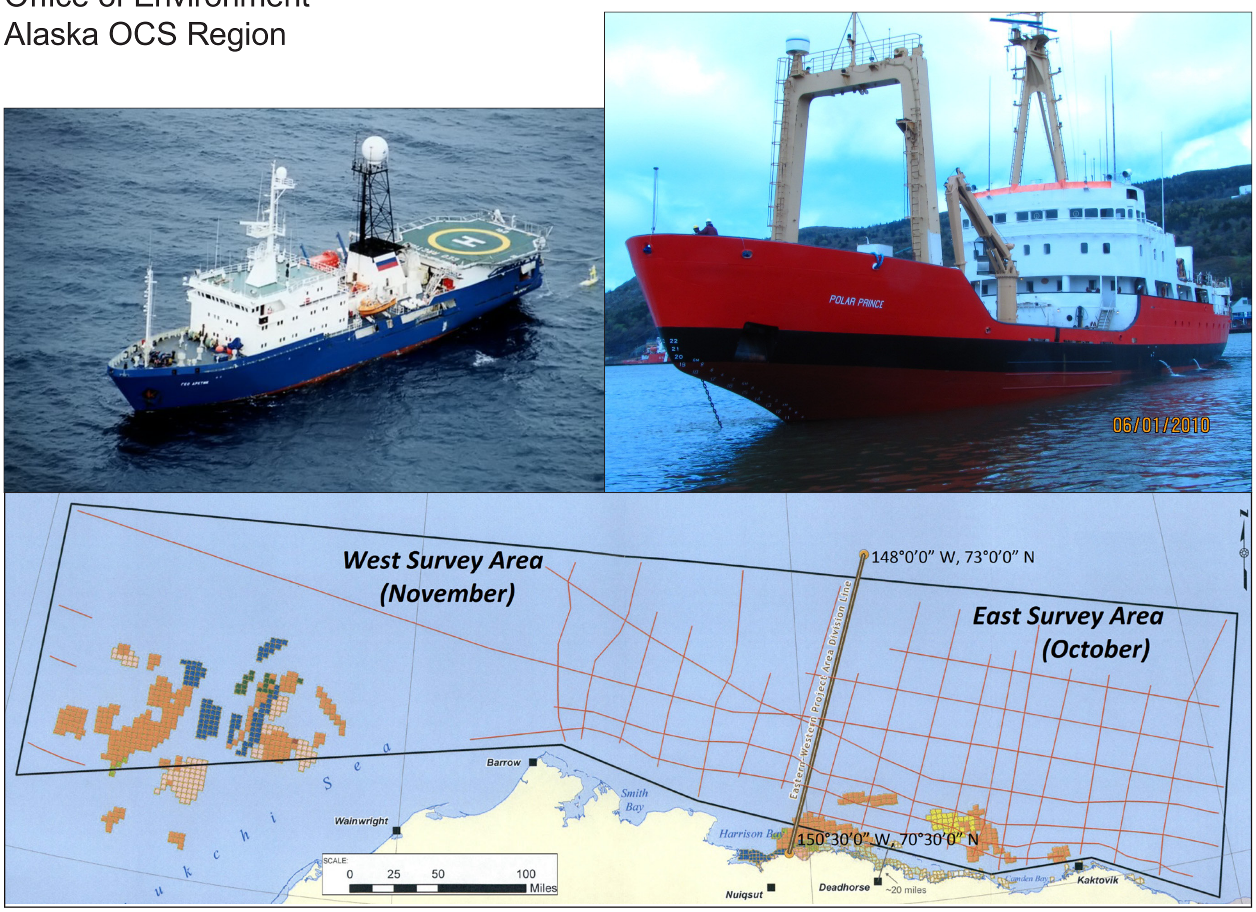
Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2012-081

ION Geophysical
2012 Seismic Survey
Beaufort Sea and Chukchi Sea, Alaska

ENVIRONMENTAL ASSESSMENT

Prepared By:
Office of Environment
Alaska OCS Region



Cover Illustrations provided by ION Geophysical for ION G&G Permit Application #12-01

U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region

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Acronyms and Abbreviations

~ ....Approximately
AAC ....Alaska Administrative Code
ACIA ....Arctic Climate Impact Assessment
ACP ....Arctic Coastal Plain
ADEC ....Alaska Department of Environmental Conservation
ADF&G ....Alaska Department of Fish and Game
AEWC ....Alaska Eskimo Whaling Commission
AFMP ....Arctic Fishery Management Plan
AO ....Arctic Oscillation
AQCR............................Air Quality Control Regions
bbl..................................Barrel/Barrels
BOEM ....Bureau of Ocean Energy Management
BOEMRE ....Bureau of Ocean Energy Management, Regulation and Enforcement
CAA ....Clean Air Act or Conflict Avoidance Agreement
CEQ...............................Council on Environmental Quality
CFR ....Code of Federal Regulations
CO ....carbon monoxide
COMIDA.......................Chukchi Offshore Monitoring in Drilling Area
CWA..............................Clean Water Act
dB re 1 μPa ....Decibels in Relation to a Reference Pressure of 1 Micropascal
DPP................................Development and Production Plan
EA..................................Environmental Assessment
EEZ................................U.S. Exclusive Economic Zone
EFH ....Essential Fish Habitat
EIS ....Environmental Impact Statement
EJ ....Environmental Justice
EP ....Exploration Plan
EPA ...............................U.S. Environmental Protection Agency
ESA ....Endangered Species Act
FLIR ....Forward Looking Infrared (a forward looking thermal imaging camera system)
FMP ....Fishery Management Plan
FONSI ....Finding of No Significant Impact
FR ....Federal Register
FWS...............................U.S. Fish and Wildlife Service
G&G ....Geological and Geophysical
hr....................................Hour
Hz ....Hertz
IHA................................Incidental Harassment Authorization
in....................................Inch
ION................................ION Geophysical, Inc.
IPCC..............................Intergovernmental Panel on Climate Change
ITA ....Incidental Take Authorization
IWC ....International Whaling Commission
kt....................................Nautical Mile Per Hour (1 Knot = 1.853 Km/H)
kW ....Kilowatt
Lease Sale 193...............Chukchi Sea OCS Lease Sale 193
LOA...............................Letter of Authorization
m....................................Meter
min.................................Minute
MMO ....Marine Mammal Observer
MMPA...........................Marine Mammal Protection Act
MMS..............................Minerals Management Service
M/V ....Marine Vessel
NAAQS ....National Ambient Air Quality Standards

NEPA............................ National Environmental Policy Act
NHPA........................... National Historic Preservation Act
NMFS........................... National Marine Fisheries Service
NMML.......................... National Marine Mammal Laboratory
NO_2 .... Nitrogen Dioxide
NOAA.......................... National Oceanic and Atmospheric Administration
NO_x............................... Nitrogen Oxides
NPDES......................... National Pollutant Discharge Elimination System
NPFMC........................ North Pacific Fisheries Management Council
NSB.............................. North Slope Borough
OCSLA......................... Outer Continental Shelf Lands Act
OCS.............................. Outer Continental Shelf
PEA.............................. Programmatic Environmental Assessment
PM................................ Particulate Matter
PSD............................... Prevention of Significant Deterioration
psi................................. Pounds Per Square Inch
PSO............................... Protected Species Observer
s.................................... Second
SBS............................... Southern Beaufort Sea Stock of Polar Bears
SEIS.............................. Supplemental Environmental Impact Statement
SHPO............................ State Historic Preservation Act
SO_2................................ Sulfur Dioxide
TTS............................... Temporary Threshold Shift
U.S................................ United States of America
USC.............................. United States Code
USDOC......................... U.S. Department of Commerce
USDOI.......................... U.S. Department of the Interior
USFWS......................... U.S. Fish and Wildlife Service
USGS............................ United States Geological Survey
VOC.............................. Volatile Organic Compounds
VGP.............................. Vessel General Permit

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1.0 PURPOSE AND NEED

1.1. Purpose of the Proposed Action

ION Geophysical (ION) submitted a Geological and Geophysical (G&G) permit application to the Bureau of Ocean Energy Management (BOEM) on March 9, 2012, to conduct a two-dimensional (2D) seismic survey in the U. S. Beaufort Sea and Chukchi Sea (ION, 2012a). The proposed survey would extend from the U.S.–Canada exclusive economic zone (EEZ) on the east to Point Barrow on the west with two survey lines extending west of Point Barrow into the Chukchi Sea and three smaller lines segments along the western edge of the survey area (Figure1). The survey would acquire seismic, gravity, and magnetic data from October 1 to December 15, 2012. On September 21, 2012, ION informed BOEM that the start of the program was delayed until October 17 and that the vessels would enter the Proposed Action area from the southwest.

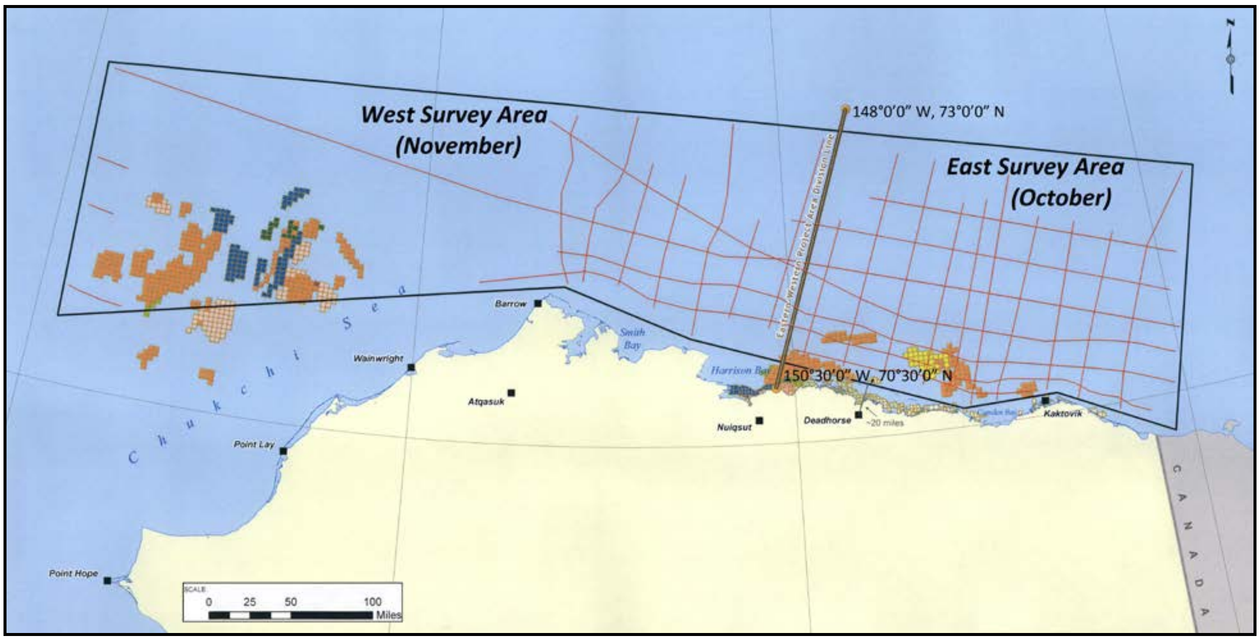


Figure 1. Proposed survey lines for 2012 G&G Seismic Survey, Oct 1 through Dec 15, 2012.

Note: The solid gray line running from eastern Harrison Bay NNE to 148°0'0", 73°0'0" indicates the division between the "East Survey Area" and the "West Survey Area" (ION, 2012b).

The purpose of ION's proposed 2012 G&G Seismic Survey (hereafter called the "2012 ION Proposed Action" or "Proposed Action") is to image the subsurface geological structures in the region, providing geologists and geophysicists with information to better evaluate prospects for potential oil and gas reserves. The data obtained will allow ION to view and interpret large scale subsurface geologic structural features. This information will provide critical insight into the geologic evolution, basin architecture, and depositional and structural history of the petroleum system.

The need for this action is established by BOEM's responsibility under the Outer Continental Shelf Lands Act (OCSLA) to make the Federal offshore available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs.

BOEM has prepared this Environmental Assessment (EA) to determine whether the Proposed Action would result in significant effects to the environment, and to assist with BOEM planning and decision-making in accordance with the following:

- National Environmental Policy Act (NEPA).
- Council on Environmental Quality (CEQ) regulations at 40 CFR 1501.3(b) and 1508.27.
- Department of the Interior (DOI) regulations at 43 CFR Part 46.
- DOI policy in Section 516 of the Department of the Interior Manual (DM) Chapter 15 (516 DM 15).

BOEM issues permits for exploration seismic surveys within U.S. waters pursuant to 30 CFR Part 551.

1.2. Background

BOEM approved an ION application and issued a permit to ION for a similar survey in 2010. The survey was later cancelled by ION. ION submitted, but later withdrew, another G&G survey application during 2011.

The 2012 ION Proposed Action is designed to support future oil and gas exploration within the Proposed Action area. Two vessels would be used for the proposed 2012 operations. The Marine Vessel (M/V) *Geo Arctic* (*Geo Arctic*) would be the seismic source vessel and the M/V *Polar Prince (Polar Prince)* would be the icebreaker/refueling/support vessel, providing advanced emergency medical support and medical evacuation coordination.

In support of the 2012 ION Proposed Action, ION submitted the following:

- An Incidental Harassment Authorization (IHA) application to the National Marine Fisheries Service (NMFS) and a Letter of Authorization (LOA) request to the U.S. Fish and Wildlife Service (FWS) on March 1, 2012.
- An application for Permit to Conduct Geological or Geophysical Exploration for Mineral Resources or Scientific Research on the Outer Continental Shelf (BOEM forms 0327 and 0328) (ION, 2012a).
- Plan of Operations (submitted on June 11, 2012) (ION, 2012b).
- Environmental Assessment of a Marine Seismic Survey by ION Geophysical in the Arctic Ocean, October-December 2012 (LGL, 2012).
- Marine Mammal Monitoring and Mitigation Plan (June 5, 2012) (ION, 2012c).
- An IHA application to the NMFS (submitted March 1, 2012).
- A LOA request to the United States Fish and Wildlife Service (FWS) (submitted March 1, 2012).
- A Final Plan of Cooperation (POC) (ION, 2012d) to reduce potential conflicts with subsistence activities was delivered to affected communities, NMFS, FWS, and BOEM on July 24, 2012, as part of the application process.

1.3. Previous Applicable Analyses

NEPA (42 USC 4321 et seq.) requires Federal agencies to use a systematic, interdisciplinary approach to protecting the human environment. This approach ensures the integrated use of the natural and social sciences in any planning and decision-making that may have an impact on the environment. The level of NEPA review depends on the OCSLA stage (516 DM 15), the scope of the Proposed Action, and the agency’s findings on the potential effects of the Proposed Action.

The BOEM has completed numerous NEPA reviews of Beaufort Sea and Chukchi Sea OCS activities. NEPA reviews and other analyses that are relevant to the Proposed Action and/or the Proposed Action area include the following:

- Environmental Assessment, Beaufort Sea and Chukchi Sea Planning Areas, ION Geophysical, Inc. Geological and Geophysical Seismic Surveys, (OCS EIS/EA BOEMRE 2010-027) September 2010 (USDOI, BOEMRE, 2010a) (hereafter “2010 ION Seismic Survey EA”).
- Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf, Seismic Surveys – 2006 (OCS EIS/EA MMS 2006-038) June 2006 (USDOI, MMS, 2006) (hereafter “2006 Seismic PEA”).
- Environmental Assessment - Shell Offshore, Inc., 2012 Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska. (OCS EIS/EA BOEMRE 2011-039) (USDOI, BOEMRE, 2011a) (hereafter “2012 Shell Camden Bay EP EA”).
- Environmental Assessment - Shell Gulf of Mexico, Inc., 2012 Revised Outer Continental Shelf Lease Exploration Plan, Chukchi Sea, Burger Prospect, Alaska. (OCS EIS/EA BOEM 2011-061) (USDOI, BOEM, 2011) (hereafter “2012 Shell Chukchi Sea EP EA”).
- Final Environmental Impact Statement, Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195 and 202—2003 (OCS EIS/EA MMS 2003-001) February 2003 (USDOI, MMS, 2003) (hereafter “Beaufort Sea Multiple-Sale EIS”).
- Final Environmental Impact Statement, Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026) May 2007 (USDOI, MMS, 2007b) (hereafter “Lease Sale 193 and Seismic Surveying EIS”).
- Final Supplemental Environmental Impact Statement, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 (OCS EIS/EA BOEMRE 2011-041) 2011 (USDOI, BOEMRE, 2011b) hereafter “Lease Sale 193 SEIS”).

The EA and EIS documents above are available on the BOEM Alaska website at: http://www.boem.gov/ak-eis-ea/. Relevant sections of some of these documents are summarized and incorporated by reference in this EA.

This EA builds upon these previous analyses by analyzing site- and project-specific information, and by incorporating new information from recent scientific studies.

The EA also considers information and analysis submitted by the project applicant. BOEM reviewed ION’s environmental assessment prepared by LGL (2012) as well as ION’s other documentation. Consistent with 40 CFR 1506.5(a), BOEM independently evaluated the applicant's analysis and supplemented the applicant's analysis where necessary.

> 40 CFR 1506.5 Agency responsibility.
>
> (a) Information. If an agency requires an applicant to submit environmental information for possible use by the agency in preparing an environmental impact statement, then the agency should assist the applicant by outlining the types of information required. The agency shall independently evaluate the information submitted and shall be responsible for its accuracy. If the agency chooses to use the information submitted by the applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers (Sec. 1502.17). It is the intent of this paragraph that acceptable work not be redone, but that it be verified by the agency.

2.0 ALTERNATIVES

2.1. Summary of Alternatives

This Environmental Assessment (EA) examined the following alternatives:

- Alternative 1- No Action, in which BOEM would disapprove the 2012 ION G&G Seismic Survey Application #12-01 and ION's proposed seismic survey would not occur.
- Alternative 2 – Proposed Action, in which BOEM would approve the 2012 ION G&G Seismic Survey Application #12-01 and ION's proposed 2D seismic survey would occur in the U.S. Beaufort Sea and Chukchi Sea beginning no sooner than October 17 and concluding no later than December 15, 2012.

2.2. Other Alternatives Considered but Not Analyzed

- A 2012 Open-water Seismic Survey, in which BOEM would permit ION to conduct an open-water-only seismic survey. This would be equivalent to BOEM approval of ION's proposed "Alternative Action: Another Time" (LGL, 2012). This alternative is not analyzed further because (1) timing of BOEM's review and decision on the Proposed Action will be concluded too late in the year to allow the proposed survey to be conducted during the 2012 open-water season and (2) ION would be required to submit a new permit application to conduct an open-water-only survey during 2013. In effect, requiring ION to conduct the proposed survey in open-water conditions would be equivalent to disapproving the ION 2012 Proposed Action (No Action Alternative).
- A multi-year seismic survey during which a portion of the desired survey would be completed each year until the Proposed Action survey program would eventually be completed is not analyzed further. Although the negative impacts during any given year might be lower due to reduced area coverage, spreading the impacts over multiple seasons likely would not decrease the overall level of impact from the project. Because a G&G permit authorizes activities for a maximum of one year, this alternative would require ION to submit new applications each subsequent year. Multi-year activities would increase the number of vessel transits to and from the survey area for each additional project year.
- The use of alternative technologies to acquire geological and geophysical data. The alternatives to using an impulsive airgun as a sound source include:
    - Marine Vibrators (hydraulic and electric)
    - Low-frequency Acoustic Source
    - Deep-Towed Acoustics/Geophysics Systems
    - Low Frequency Passive Seismic Methods

  Use of these alternative technologies was not considered as they are in various stages of development and none of the systems with the potential to effectively replace airguns as a seismic source are currently commercially available.

- The use of technology-based mitigation measures to lessen the impacts of airguns in the water. These include:
    - Air Gun Silencer
    - Bubble Curtain

BOEM reviewed and considered published information on the use of these mitigation measures and determined that both would be impractical using currently available technology (Spence et al., 2007; Sixma, 1996; Sixma and Stubbs, 1998).

2.3. Description of the Alternatives

2.3.1. Alternative 1 – No Action

Under Alternative 1 – No Action, BOEM would disapprove the 2012 ION G&G Seismic Survey Application #12-01.

2.3.2. Alternative 2 – Proposed Action

Under Alternative 2 – Proposed Action, BOEM would approve the 2012 ION G&G Seismic Survey Application #12-01 and ION's proposed 2D seismic survey would occur in the U.S. Beaufort Sea and Chukchi Sea beginning no sooner than October 17 and concluding no later than December 15, 2012.

2.3.2.1. Overview

ION proposes to conduct a 2D seismic survey in the U.S. Beaufort Sea and Chukchi Sea (Figure 1). Most of the survey will be in the Beaufort Sea. All survey activities associated with the Proposed Action would conclude no later than December 15, 2012.

The survey will include:

- One seismic survey vessel with a 28 airgun array.
- One medium class 100A icebreaker to break and clear ice and act as support vessel.

The survey area would extend from about latitude 69ºN to 73ºN and longitude 138ºW to 170ºW. The survey area would range from about 12 to 250 kilometers (km) offshore in water depths from less than 20 meters (m) (65 feet (ft)) to greater than 3,500 m (11,500 ft). Approximately 61% of the proposed survey lines would be conducted in water depths greater than 200 m (650 ft). The survey area would include the continental shelf, the continental slope, and the abyssal plain. The approximate total length of the proposed survey lines is 7,175 km (4,458 mi).

The Proposed Action area has been divided into an East Survey Area and West Survey Area along a line that extends north-northeast from the Coville River Delta (from 70.5° N, 150.5° W to 73° N, 148° W) (Figure 1). The East Survey Area is wholly within the U.S. Beaufort Sea and the West Survey Area includes both the U.S. Beaufort Sea and the Chukchi Sea. ION plans to begin seismic survey operations in October in the East Survey Area, in offshore waters deeper than 1,000 m (3,280 ft). The survey would proceed into shallower waters in the East Survey Area before moving to the West Survey Area in late October or early November. Operations would take place in open-water and first-year ice with ice coverage during the survey expected to range from open water to 10/10 (91%-100%) ice cover.

The Proposed Action also includes collection of gravity and magnetic data. These surveys involve no introduction of energy into the marine environment. Because gravity and magnetic surveys are passive data collection, they will not be further analyzed in this EA.

2.3.2.2. Seismic Survey and Support Vessels

ION would conduct seismic survey operations using the seismic vessel M/V *Geo Arctic*, a Russian A2 ice class vessel, which is 81.8 m long with a beam of 14.8 m and a draft of 5.4 m. *Geo Arctic* has a cruising speed of 12 knots (kts), but would travel at a speed ranging from about 3-4 kts while conducting seismic operations. The vessel is equipped with standard navigation, radar, communication, and depth sounding equipment. The airguns and hydrophone streamer towed by the

Geo Arctic have been specially designed for operations in ice-covered seas. ION has previously conducted similar surveys in ice-covered waters in Canada and Greenland.

The *Geo Arctic* will follow 0.5 – 1 km (0.3 – 0.6 mi) behind the medium class 100A icebreaker *Polar Prince* whenever ice is present. *Polar Prince* will carry approximately 500 tons of Arctic diesel fuel, and is expected to perform at-sea refueling of the *Geo Arctic* during late October. *Polar Prince* is 67.1 m long, with a beam of 15 m and a draft of 6 m. The *Polar Prince* has a maximum speed of 14.5 knots (kts) and cruises at 11 kts. *Polar Prince* will perform any other support or supply duties as necessary.

2.3.2.3. Schedule

The *Geo Arctic* and *Polar Prince* would enter the U.S. Beaufort Sea from the Chukchi Sea on or after October 11, 2012. Survey vessels and equipment would not enter the East Survey Area until October 17, 2012, after completion of the Kaktovik and Nuiqsut subsistence bowhead whale hunts. The seismic survey is scheduled to take approximately 76 days from October 17 until termination of operations, but no later than December 15, 2012.

Before commencing the active survey, acousticians would deploy hydrophones to collect sound source measurements and determine marine mammal safety and disturbance radii. ION plans to initiate survey operations in the East Survey Area in offshore waters greater than 1,000 m deep. The survey would progress to shallower waters in the East Survey Area before moving to the West Survey Area in late October or early November. The survey would not enter the West Survey Area until completion of the Barrow bowhead whale subsistence hunt.

Refueling

Vessel refueling operations are expected to occur before beginning the survey in the OCS. No refueling will occur once operations have been initiated.

2.3.2.4. Sound Generation

The seismic sound source for the proposed geophysical survey would be an array of 28 Sercel G-gun airguns with a total operating volume of 4,450 in^3 (two airguns would serve as spares). The 28 airguns would be configured in two 14 airgun sub-arrays with individual airgun sizes ranging from 70 to 380 in^3 operating at a pressure of 2,000 psi. The sub-arrays would be towed 25 - 50 m (82 - 164 ft) behind the *Geo Arctic* at a depth of approximately 8.5 m (28 ft). The *Geo Arctic* would follow pre-determined track lines at a speed ranging between 3 kts and 4 kts with the airgun array discharging at approximately 18 second intervals or a linear spacing of 37.5 m (123 ft).

The *Geo Arctic* would tow a hydrophone streamer to receive signals reflected from the seafloor and subsurface geological strata, and transfer the data to an on-board processing system. ION is proposing to use a single 9 km (5.6 mi) or 4.5 km (2.8 mi) long hydrophone streamer towed approximately 9.5 m (31 ft) below the surface. Proprietary units attached to the streamer at 300 m (980 ft) intervals provide lateral control and aid in keeping the streamer at the desired deployment depth. The *Geo Arctic* would be restricted in its ability to maneuver while towing the streamer and would require a 10 km (6.2 mi) run-in at the start of a seismic line, and a 4-5 km (2.5-3.1 mi) run-out at the end of a line.

The *Geo Arctic* and *Polar Prince* will operate maritime industry standard echo sounders / fathometers continuously while underway to provide water depth information and ensure vessel safety. These acoustic energy sources would operate simultaneously with the airgun array.

2.3.2.5. Monitoring and Mitigation

ION's proposed seismic survey incorporates both design features and operational procedures for minimizing the potential for impacts to marine mammals and subsistence hunting. A Plan of

Cooperation (POC) between potentially affected communities and ION has been developed to avoid conflicts with subsistence hunting (ION, 2012d). Additionally, ION has signed a Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission (AEWC).

Mitigation Measures Include:

- The survey has been designed to occur during periods of low marine mammal density in an effort to minimize encounters with marine mammals, most migratory animals, subsistence whale hunting, and most of the subsistence hunting activities that occur during the open-water season. This would be accomplished by:
  - — Beginning survey operations following completion of the Kaktovik and Nuiqsut subsistence bowhead whale hunts.
  - — Beginning the survey in offshore waters of the eastern U.S. Beaufort Sea deeper than 1,000 m (3,280 ft), where bowhead whale density is expected to be the lowest in the survey area.
  - — Planning the survey to proceed from east to west across the U.S. Beaufort Sea to avoid, as much as possible, any remaining migratory animals and associated subsistence activities.
  - — Proceeding toward shore in the East Survey Area after most bowhead and beluga whales have departed the area (weather and ice permitting, survey activities will remain in deep water off the continental shelf until mid-October or later).
  - — Proceeding into the West Survey Area only after the Barrow subsistence whale hunt is completed.
  - — Timing the survey to avoid subsistence hunting activities that occur during the open-water season, and to avoid most migratory marine mammals which will have departed the project area prior to the onset of operations.
  - — Completing the two survey lines which extend into the Chukchi Sea and then the western and southernmost survey line segments last, after most whales and walrus have moved south or west of the area.
  - — Completing the survey prior to the time when ringed seals would establish and enter lairs for reproductive purposes, and prior to polar bear denning.
- Speed or course alteration to avoid marine mammals entering the power down or shut down zones, provided that doing so will not compromise operational safety requirements.
- Power down or shut-down procedures will be followed if:
  - — Course correction is not adequate to keep marine mammals from entering defined exclusion zone or;
  - — A marine mammal is sighted within the appropriate (180 dB or 190 dB) exclusion zone, or;
  - — A marine mammal is detected outside of and about to enter the exclusion zone radii and the vessel’s speed and/or course cannot be corrected to avoid having the mammal enter the exclusion zone.
- No start-up of airgun operations unless the 180 dB exclusion zone is visible for at least 30 minutes (min) during day or night.

Protected Species Monitoring

Vessel-based Protected Species Observers (PSOs), formerly called Marine Mammal Observers (MMO), would monitor for marine mammals near the seismic source vessel during all daylight airgun operations and before any ramp-up of the airguns. When a full shut down of all guns, including the mitigation gun, has occurred, PSOs must visually determine that the exclusion zone is clear of all marine mammals for 30 min before ramp-up may begin. If marine mammals are observed in the water within, or about to enter, a designated exclusion zone, operations would be powered down or shut down immediately. Power down and shutdown procedures are defined explicitly in the glossary (Section 6.0). A complete power down includes shutting down the mitigation gun, and is therefore a shut down.

Protected Species Observers (PSOs): Vessel-based monitoring for marine mammals would be performed by marine mammal biologists or specially trained observers, including locally hired Iñupiat observers, throughout the survey period. An experienced field crew leader would supervise the PSO teams onboard the vessels.

One PSO would be responsible for monitoring the forward-looking infrared (FLIR) system mounted on the *Polar Prince* during all darkness and twilight periods whenever there was a mandate for night observations, including nighttime start-ups or ramp-ups of the airgun array. Additionally, PSOs would operate FLIR during other periods to collect comparative data on the relative effectiveness of the system. ION does not propose to have PSOs on duty during ongoing seismic operations at night; instead, bridge personnel would watch for marine mammals (insofar as practical at night) and call for the airguns to be shut down if marine mammals should be observed in or about to enter the exclusion zone (the area around the seismic-survey-sound source within which marine mammals may be exposed to sounds that are considered a Level A take by NMFS. See glossary (Section 6.0)). ION states that if conditions for nighttime start-up exist, a PSO aboard the source vessel will monitor for marine mammals within the exclusion zone for 30 min prior to start-up of the airguns using either floodlights or night vision devices (NVD), and a PSO aboard the icebreaker will monitor the survey course ahead using a FLIR device.

Observer Qualifications and Training: Most PSOs would be individuals with recent experience during one or more seismic monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas. Biologist-observers would have previous marine mammal observation experience, and field crew leaders would be highly experienced with previous vessel-based marine mammal monitoring and mitigation. Iñupiat observers would be experienced in the region, familiar with the marine mammals of the area, and would complete a NMFS approved observer training course designed to familiarize individuals with monitoring and data collection procedures. A protected species observers' handbook, adapted for the specifics of the planned survey program, would be prepared and distributed to all PSOs.

Observers, including Iñupiat observers, would complete a minimum two-day training and refresher session on marine mammal monitoring before the anticipated start of the seismic survey. The training session(s) would be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs. Any personnel not receiving this training would have had equivalent experience or training. Resumes for field crew leaders would be submitted to NMFS and FWS for review and acceptance of qualifications. Field crew leaders and biologist/observers would have previous offshore marine mammal observation experience, and crew leaders would be "highly experienced with previous vessel-based marine mammal monitoring and mitigation projects" (LGL, 2012).

Number of Observers: Three PSOs would be stationed aboard the *Polar Prince*, operating 0.5 –1 km ahead of the survey vessel, to take advantage of this forward operating platform and provide advanced notice of marine mammals to the PSOs on the survey vessel. Three PSOs would be stationed aboard the *Geo Arctic* to monitor the exclusion zones. The PSOs would stand watch for a maximum of 4 consecutive hours and a maximum of 12 hours per day. PSOs would stand watch during daylight operations on each of the survey vessels.

Monitoring zones: PSOs aboard the *Polar Prince* would provide early detection of marine mammals along the survey track. PSOs aboard the *Geo Arctic* would monitor for the presence of marine mammals in two acoustic (glossary: exclusion zone) exclusion zones established around the *Geo Arctic* based on sound radii. PSOs aboard the *Geo Arctic* would request mitigation actions when necessary. PSOs would watch for marine mammals during all periods of seismic survey activity and for a minimum of 30 min prior to the planned start of airgun operations after a shut down. The 180/190 dB exclusion zones would be required to be clear of marine mammals before the start of airgun operations.

Specialized Field Equipment: ION would provide or arrange for the following specialized field equipment for use by the onboard PSOs: 7×50 reticle binoculars, +20×60 image-stabilized binoculars or 25X150 binoculars, global positioning system unit, laptop computers, night vision binoculars, and possibly digital still and digital video cameras for later verification of marine mammal identification. A forward looking infra-red camera (FLIR) would also be available.

Monitoring During Periods of Darkness and in Poor Visibility: Night-vision equipment (binocular image intensifiers) would be available for use when/if needed. A forward looking infra-red thermal imaging (FLIR) camera system mounted on a high point in front of the icebreaker would also be available to assist with detecting the presence of seals and polar bears on ice and potentially in water ahead of the survey route. PSOs would not routinely be on duty during hours of darkness. If the airguns need to be ramped up following a power down after dark, a PSO aboard the *Geo Arctic* would monitor for the presence of marine mammals near the source using either floodlights or a night vision device (NVD), and a PSO aboard the *Polar Prince* would monitor the area ahead along the survey course using a forward-looking infrared (FLIR) system. Start-up or ramp-up of the seismic airgun array would not proceed unless the marine mammal exclusion zones were visible and no marine mammals were detected within the appropriate exclusion zones; or until 15 min (for small toothed whales and ice seals) or a minimum of 30 min (for baleen whales) after there was no further visual detection of the animal(s) within the exclusion zone and no marine mammals remained within the appropriate exclusion zone.

Other mitigation associated with active seismic operations during periods of darkness or poor visibility includes the following:

- During periods of poor visibility, such as foggy conditions or darkness, the full 180 dB (rms) exclusion zone might not be visible. In that case, the airguns would not start-up after a full shut down until the entire 180 dB radius is visible.
- During any operations after dark, if the 180 dB exclusion zone were visible using vessel lights, NVD's and/or FLIR, then start-up of the airgun array could occur following a 30-min period of observation with no sightings of marine mammals within the exclusion zone.
- If one or more airguns were in operation prior to the onset of darkness or poor visibility, operations could continue unless a marine mammal entered the power down or shut down zone.

Mitigation

Sound Source Verification (SSV): ION would conduct sound source verification testing in the field to verify the radii of the isopleths (to determine the exclusion zones) under field conditions to provide a more accurate determination of monitoring zone radii prior to the start of the survey.

Shut Down/Power Down Procedures. Air gun operations would not be conducted when marine mammals were present within the exclusion zones (180 dB for cetaceans and walrus and 190 dB for polar bears and ice seals). If a marine mammal was observed within the exclusion zone the airguns would be powered down until the animal was no longer in the zone. If the animal moved toward the vessel and reached the exclusion zone of the mitigation gun, the airgun would be shut down and the seismic survey would be suspended until the exclusion zone was clear of marine mammals. PSOs would notify geophysical operators immediately if a marine mammal was observed within the exclusion zone so that mitigation measures called for by the IHA and LOA could be implemented. If the airgun array were shut down for any reason during darkness or poor visibility conditions, it could not be started up until visibility conditions allowed for the exclusion zone to be effectively monitored.

Ramp-up Procedures. Ramp-up is the gradual introduction of sound into the environment to “warn” marine mammals in the vicinity of the airguns and to provide the time necessary for them to leave the area and avoid any potential injury or impairment to their hearing abilities. This technique involves the gradual increase (usually 5-6 dB per 5-min increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of 20 to 40 min, until the desired operating level of the full array is obtained. Ramp-up procedures following a power down could begin after observers witness the marine mammal departing the exclusion zone or after no marine mammals appear within the exclusion zone for a minimum of 15 min for ice seals and polar bears, or 30 min for baleen whales and Pacific Walrus.

Start-up and ramp-up after a shut-down would not begin until there had been a minimum of 30 min of observation of the exclusion zone by PSOs and no marine mammals are in evidence. The entire exclusion zone would be required to be visible during the 30 min lead-in to a full ramp-up. If the entire exclusion zone were not visible, then ramp-up from a cold start could not begin. If any marine mammals were sighted within the exclusion zone during the 30 min watch prior to ramp-up, ramp-up would be delayed until the marine mammal(s) were observed departing the exclusion zone or no marine mammals were sighted for at least 15 min for ice seals and polar bears, or 30 min for baleen whales and Pacific Walrus.

If a single mitigation airgun was used when conducting routine activities, such as line turns and equipment maintenance, or during periods of impaired visibility (e.g., darkness, fog, high sea states) it would not be necessary to clear the exclusion zone before commencing ramp-up procedures, as long as there are no marine mammals visible in the area.

ION proposes that during turns and transit between seismic transects, at least one airgun would remain operational as a mitigation gun. The ramp-up procedure would still be followed when increasing the source levels from one air gun to a full array, but the start-up procedure would not be necessary due the deterrence effect of the mitigation gun. Through use of this approach, seismic operations could resume upon beginning a new survey line without the associated 30-min lead-in observations. PSOs would be on duty whenever the airguns are in operation during daylight, during the 30-min periods prior to start-up as well as during ramp-up. The seismic operator and PSOs would maintain records of the times when ramp-ups start, and when the airgun arrays reach full power. Ramp-up would not occur unless the PSOs have sufficient visibility to determine if the 180/190 dB exclusion zone for the full array is clear, or at least one mitigation airgun has been in continuous operation. PSOs may use night vision binoculars, floodlights, and/ or FLIR to aid visibility during periods of darkness.

Exclusion Zone. ION would follow current NMFS and FWS guidelines, as outlined in their IHA and LOA, when determining exclusion zones. Exclusion zones for marine mammals are defined by NMFS and FWS as the distances within which received sound levels are ≥180 dB re 1 Pa (rms) for whales and walrus and ≥190 dB re 1 Pa (rms) for ice seals and polar bears based on work by Richardson et al., (1995a as cited in LGL, 2012). These criteria are based on an assumption that sound energy at lower received levels would not injure these animals or impair their hearing abilities, but that higher received levels might cause effects such as temporary threshold shifts (TTS). Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the exclusion radii, or at sound levels that are lower than the 180/ 190 dB received sound level (Richardson et al., 1995a as cited in LGL, 2012).

ION modeled received sound levels for the full 28 airgun, 4450 in^3 array in relation to distance and direction from the source (Zykov, Deveau, and Hannay, 2010, as cited in LGL, 2012). Based on the model results, Table 1 shows the distances from the airguns at which ION predicts that sound levels of 190, 180, and 160 dB re 1 μPa (rms) would be received. Underwater sound propagation of a 30 in^3 airgun was measured near Harrison Bay in 2007 and the results were reported in Funk et al. (2010). The constant term of the resulting equation was increased by 2.45 dB based on the difference of the volume between the two airguns. The 190 dB and 180 dB distances based on those measurements, 19 m and 86 m respectively, would be used as the exclusion zones during use of the single 70 in^3 mitigation airgun until results from field measurements are available.

Table 1. Sound propagation distance in meters as a function of water depth for ION's proposed airgun array.

Received Sound Level (dB re 1 μPa rms)	Water Depth (m)		
	<100	100-1,000	>1,000
190	600 m	180 m	180 m
180	2,850 m	660 m	580 m
160	27,800 m	42,200 m	31,600 m

ION plans to measure received sound levels as a function of distance from the array prior to commencing survey activities U.S. Beaufort Sea. These field data would be modeled together with data from past sound source measurements completed in the U. S. Beaufort Sea with similar arrays to estimate appropriate exclusion radii for use during the survey.

Operations Reports. ION would provide a weekly operations report as required by BOEM. Any harm or mortality to a marine mammal must be reported to NMFS or FWS, as appropriate, including information on the frequency of occurrence and the types and behaviors of marine mammals (if possible) entering the exclusion zones.

In addition, BOEM will require, as a condition of permit approval, that any harm or mortality to a marine mammal must be reported to BOEM immediately. This report would be used as an adaptive management tool to monitor disturbance events during the survey, and to alter survey plans if necessary to avoid unnecessary or excessive disturbance.

Speed or Course Alteration. If a marine mammal was observed in the water outside of the exclusion zone and, based on its position and relative motion, appeared likely to enter the exclusion zone, the vessel's speed and/or course could, when practical and safe, be changed in a manner that also minimized the effect on the planned objectives. Marine mammal activities and movements relative to the *Geo Arctic* would be closely monitored to ensure that marine mammals do not enter the exclusion zone. If the mammal appeared likely to enter the exclusion zone, further mitigation actions would be taken, i.e., either additional course alterations or a power down or shut down of the airgun(s).

2.4. BOEM Proposed Mitigation

This section presents potential additional monitoring and mitigation that, if implemented, could further mitigate potential adverse effects to marine mammals in the survey area. If the additional monitoring and mitigation measures are adopted, approval of the 2012 ION G&G Seismic Survey Application #12-01 could be conditioned on adherence to the restrictions described below.

BOEM has previously recommended that a PSO be on duty during all periods when a seismic array is operating, day and night (USDOI, MMS, 2010). Under the proposed action herein, PSOs would not routinely be on duty during hours of darkness, but would be required if airguns need to be ramped up following a power down after dark. Moreover, if a full shut down occurs during periods of poor visibility (such as fog or darkness), airguns would not start up again until the entire 180 dB radius is visible (see Section 2.3.2.5 – Monitoring and Mitigation - Monitoring During Periods of Darkness and in Poor Visibility).

Furthermore, to ensure compliance with the Marine Mammal Protection Act (MMPA), ION has applied to NMFS and FWS for incidental take authorizations (ITA) in the form of an incidental harassment authorization (IHA) or letter of authorization (LOA), respectively. Receipt of the ITAs before commencing BOEM-permitted seismic-survey activities will be required by BOEM. The mitigation and monitoring requirements in these ITAs will further ensure that potential impacts to marine mammals will be negligible and that there will be no unmitigable impacts to the availability of subsistence resources.

Proposed Mitigation:

- The vessels must remain at least 30 miles from whaling activities when transiting the West Survey Area to begin operations in the East Survey Area. Vessels shall maintain communication with the Alaska Eskimo Whaling Commission and the Barrow Whaling Captains' Association during the eastward transit around Pt. Barrow.

On September 21, 2012, ION informed BOEM that the start of the program was delayed until October 17 and that the vessels would enter the Proposed Action area from the southwest. The seismic vessel *Geo Arctic* is scheduled to arrive in Nome on October 7, 2012, to unload poorly functioning equipment and take on spare equipment. The vessel is expected to depart Nome for the Proposed Action area on October 11. The *Geo Arctic* and *Polar Prince* will transit the Chukchi Sea and round Point Barrow to reach the East Survey Area. Bowhead whaling may still be underway at Barrow.

BOEM proposes to require the following measure to avoid potential conflicts with whaling activities. The 30 mile offset from whaling activities in the measure is based on the agreed upon separation to reduce conflicts with bowhead whaling in ION's Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission. Without this mitigation measure, the transit to the East Survey Area could potentially have an adverse impact on the subsistence hunt. BOEM finds the mitigation reasonable because it should avoid any adverse effects to the subsistence hunt and because the Alaska Eskimo Whaling Commission has already indicated agreement that it will sufficiently avoid potential conflict.

3.0 AFFECTED ENVIRONMENT

The following subsections summarize environmental conditions that could affect or be affected by the Proposed Action. Each summary focuses on information relevant to understanding potential environmental impacts. More detailed discussion of the marine, coastal, and human environment of the Beaufort Sea and Chukchi Sea Planning Areas is contained within the broader NEPA documents listed in Section 1.3.

3.1. Expected Operating Conditions

The North Slope of Alaska, adjacent to the Chukchi Sea and the Beaufort Sea, is classified as a polar tundra climate characterized by moderate winds, cold temperatures during the winter, cool temperatures in the summer, and little annual precipitation (Ahrens, 2009). The region is dominated by subfreezing temperatures for most of the year, and the area is almost totally ice covered from early December to mid-May. During the fall and winter months, winds can be strong and prolonged, leading to extreme ice pressures and dangerous wind-chill conditions. Over the Beaufort Sea, strong east winds are influenced by channeling by the Brooks Range to the south. Winds over the Chukchi Sea are more northwesterly in the autumn and winter months. Following a brief warm and snow-free season during June, July, and August, temperatures will fall sharply, skies will be partly cloudy, and precipitation will decrease gradually throughout the period from October through December.

3.1.1. Climate Change

The Arctic climate has experienced very large cyclical variations over the past two million years and other changes, e.g., temperature increases and reduction in sea-ice thickness, have taken place abruptly over just a few decades (ACIA, 2005). The driving factors are complex but involve changes in solar radiation, atmospheric circulations, ocean circulations, and the cryosphere. While climate is considered long-term average weather, there are mechanisms that cause systematic changes to the climate. A long time-scale climate mechanism is associated with the high latitudes of the Arctic, referred to as the Arctic Oscillation (AO). Occurring every 10 to 30 years, the AO is characterized by changes in the severity of winter weather and the frequency of storms. Fluctuating between positive and negative phases, the AO phase defines the location of pressure systems that drive weather systems. In the positive phase, there is higher pressure at the middle latitudes while lower pressure rests over the Arctic. This phase steers storms farther north and brings wet and warmer weather to Alaska. Conversely, in the negative phase the situation is reversed and there is higher-than-normal pressure over the Arctic and lower-than-normal pressure in the middle latitudes causing cold air to plunge into the Midwestern United States. The AO was in a negative phase in the 1960s, and showed a more positive trend in the 1970s through the 1990s. The Arctic experienced a strong negative phase during 2009-2010. The current and near-future AO phase is indeterminate.

Climate change, evident in the Arctic, is expected to continue. One of the effects of change is the increased loss of sea ice. The loss of sea-ice could increase the presence of internal waves bringing deep waters that are rich in nutrients to the surface. There may be effects to habitat and other natural resources that could change the distribution and abundance of particular species. Climate change could shift migration routes or affect food sources of several species or species groups. Coastal erosion could occur that alters habitat, and storm surges may produce changes in the dynamics of rivers and deltas affecting fish populations.

3.1.2. Meteorology

The proposed seismic operations would occur from October 17, 2012 through December 15, 2012, in the Beaufort Sea and Chukchi Sea OCS. The average temperature in October will range from 16°F to 32°F and by December the average temperature will drop below zero. The low temperature in December across the region will average -18°F while record lows will be as low as -50°F (WRCC, 2012). Most of the annual precipitation falls in the summer and less than an inch would be expected during the late autumn and early winter. The average wind speed can be expected to be 6-11 miles per hour and the winter winds are generally from the northeast, although winds in the Beaufort Sea can turn west in December. A multiyear meteorological study that includes data from stations along the Beaufort Sea coastline at Barter Island, Kaktovik, Deadhorse, and Nuiqsut suggests the trend for wind patterns on the North Slope are influenced by the Brooks Range (Veltkamp and Wilcox, 2007). The study shows that regardless of whether the winds are from the east or west, the flow over the eastern portion of the Beaufort Sea coastline is influenced by the Brooks Range, which can effect wind direction as far as 30 miles offshore along the area extending from Camden Bay to Mackenzie Bay. The incidence of wind channeling is strongest on the eastern coastline near Barter Island. Influence from the mountain range decreases to the west and shows little impact west of Barrow where wind direction in the Chukchi Sea is influenced more by surface pressure systems.

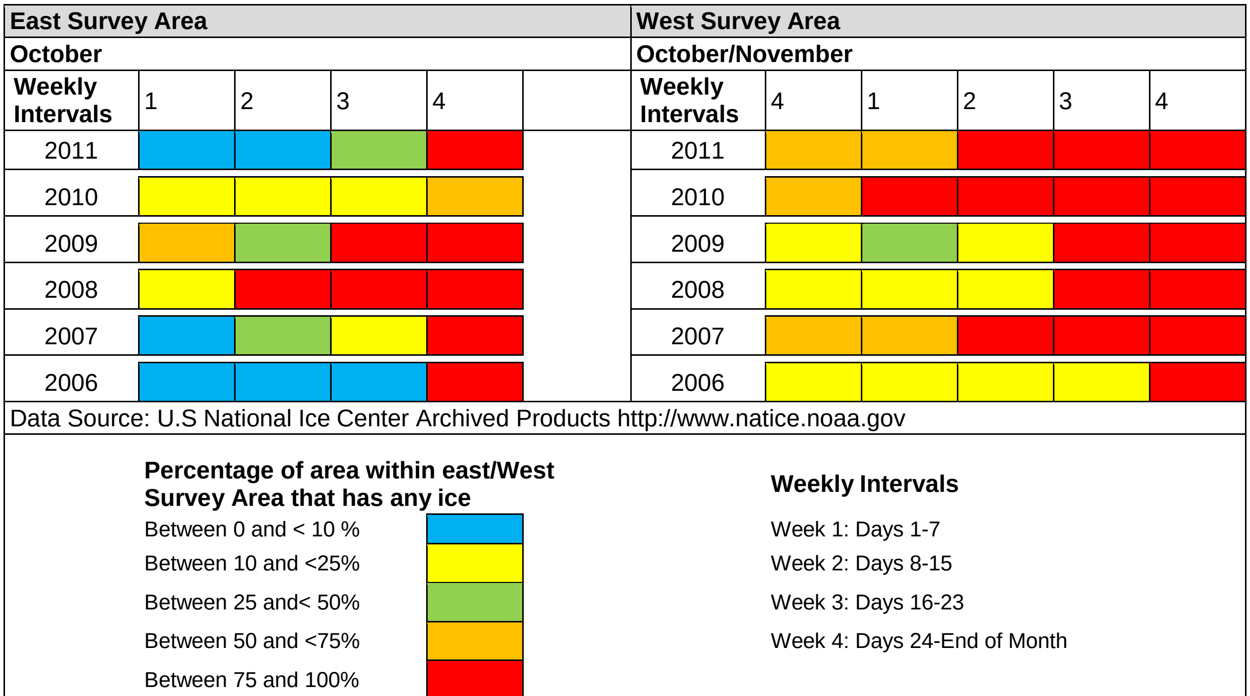
When considering the average wind speeds and temperatures common to the North Slope, daily wind chills will likely be 15°F to around zero by late October, dropping into the -10°F to -15°F range in the event of a late fall storm. There are approximately 6 to 10 storm days in the late autumn and winter, where a storm is defined by wind speeds of 34 miles per hour or more. Storms have been known to last 8 to 14 days. Occasional sudden storms can occur and the lack of natural wind barriers results in unrestricted winds. These storms bring cold temperatures and occur most frequently between September and November. The combined effect of cold temperatures and strong winds during storms makes the North Slope a risk to persons exposed to outside conditions for even brief periods of time.

3.1.3. Ice Conditions

The concentration of Arctic sea ice reaches its northern minimum in mid to late September. The Arctic sea ice begins growing southward again with the onset of freezing temperatures. In the Chukchi Sea and Beaufort Sea, the landfast ice begins forming in early October in the lagoons and late October to early November in the nearshore region (Mahoney et al., in prep.). A weekly analysis of the National Ice Center sea ice data, from 2006 through 2011, shows great variability in sea ice coverage during October and November (Table 2). Sea ice coverage in the survey area generally increases from late October to late November.

The predominant ice stages within the East Survey Area in October are thin first-year ice (30-70 cm), new ice, and young ice (10-30 cm) in patches and small floes; however, multiyear ice floes can be blown by wind into the East and West Survey Areas at any time. Predominant ice stages within the west area in late October and November are thin first-year ice, new ice, and young ice in patches and small floes.

Table 2. Percent of Ice Coverage, East and West Survey Areas: October / November Weekly 2006 - 2011.



Source: USDOI, BOEM (2012)

3.1.4. Sea State

East northeast winds predominate in the Beaufort Sea and Chukchi Sea in October and November and the scalar mean wind speed ranges from 6 to 7 meters per second (m/s) (Brower et al., 1988; Weinzapfel et al., 2011). With the onset of ice cover in October and November, wave height diminishes and is generally < 1.5 m (Brower et al., 1988).

3.2. Resources

3.2.1. Air Quality

The existing condition of air quality in the local vicinity of the Proposed Action is largely a function of meteorological conditions, mainly wind, over the open sea and emission sources existing on the coastline of the North Slope. The offshore waters of the Beaufort Sea and Chukchi Sea typically experience periods of strong winds, which have a tendency to disperse and mix air pollutants within the surrounding air. When air pollutants are transported by the wind from a source, the gases and particles disperse throughout the immediate area resulting in concentrations that are lower than when the pollutants were released at the source. The decrease in concentration reduces the environmental impact of the emissions. The major local sources of industrial emissions are in the Prudhoe Bay/Kuparuk/Endicott oil-production complex. Along with wind conditions, the limited industrial development and low population density result in low pollutant concentrations that have not resulted in degradation of the local air quality sufficient to exceed federal standards. Consequently, the air quality onshore and throughout the Chukchi Sea and Beaufort Sea OCS is characterized as good.

The U.S. Environmental Protection Agency (EPA) defines geographical areas having homogeneous air quality conditions as Air Quality Control Regions (AQCRs). The AQCRs are defined for most areas of the United States and the EPA classifies each area based on the concentration of six pollutants known to have adverse effects on human health and the welfare of animals and wildlife. The EPA has set numerical limits for these six pollutants that define the maximum limit of affected healthful air; the pollutants are therefore referred to as the "criteria pollutants." The maximum allowable limits are established under the Clean Air Act (CAA) as the National Ambient Air Quality Standards (NAAQS) and include carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead, ozone, and particulate matter (PM). When an AQCR consistently does not exceed any of the NAAQS, the area is designated by the EPA as an "attainment area." Any area consistently exceeding one or more of the NAAQS is designated as a "non-attainment area." Some areas are designated as "unclassified" when sufficient information is unavailable to classify areas as attainment or non-attainment. All areas of the North Slope adjacent to the Beaufort Sea and Chukchi Sea are classified as attainment areas.

The provisions of Alaska's Prevention of Significant Deterioration (PSD) program are applied to attainment areas and unclassified AQCRs that have good air quality. The purpose of the program is to limit degradation from industrial development. The areas are classified as PSD Class I, II, or III areas (in decreasing order of relative protection) based on land use. The North Slope adjacent to the Beaufort Sea and Chukchi Sea is classified as a PSD Class II area. Industrial and commercial growth is permissible within PSD Class II areas as long as the growth does not cause significant degradation of existing air quality or an exceedance of the NAAQS.

3.2.2. Water Quality

Water quality in the Beaufort Sea has been documented in studies and regulatory programs over several years. There is very little development in the watersheds of the U.S. Arctic and, because of this, nonpoint source pollution runoff from watersheds into the Beaufort Sea is limited. The rivers, lakes and wetlands of the region carry naturally-occurring loads of sediment, trace metals and hydrocarbons into the Beaufort Sea environment. The pathways of wind, currents, precipitation, and drifting sea-ice affect the water quality of the Beaufort Sea through long-range transport of suspended sediments and contaminants. Pollutants such as polycyclic aromatic hydrocarbons can be transported long distances and ultimately affect the U.S. Arctic. The sources of these global contaminants include: airborne industrial pollutants, vessels, existing oil and gas operations, coastal development runoff and discharges. Pollution in the Arctic is also described in the Arctic Monitoring and Assessment Programme (AMAP, 2004).

Under Section 402 of the Clean Water Act (CWA), EPA issued a National Pollution Discharge Elimination System (NPDES) Vessel General Permit (VGP) for "Discharges Incidental to the Normal Operation of a Vessel." The EPA VGP for Alaska was finalized in February 2009. The final VGP applies to owners and operators of non-recreational vessels that are 79 ft (24 m) and greater in length, as well as to owners and operators of commercial vessels of less than 79 ft (24m), which discharge ballast water.

The latest information on water-quality standards for the EPA is at 40 CFR 131 or the EPA (EPA, 2011b) web site. State of Alaska water quality standards are available at 18 AAC 70 or at the Alaska Department of Environmental Conservation (ADEC, 2011) website.

3.2.3. Lower Trophic Levels

The shallow continental shelves of the U.S. Chukchi Sea and Beaufort Sea are among the largest in the world (Grebmeier et al., 2006). These seas have some of the highest primary productivity found in the Arctic regions due to advective processes, which drive warm, nutrient-rich Pacific Ocean waters northward to meet the upwelling of deep Arctic Ocean abyssal depths in the Chukchi Sea and Beaufort Sea (Codispoti et al., 2005). The Chukchi Sea and Beaufort Sea are also strongly influenced by organic nutrients from freshwater discharges of numerous coastal rivers (Dunton, Weingartner, and Carmack, 2006). Biological processes produce a diverse invertebrate and planktonic fauna exhibiting typically short food web interactions with vertebrate predators (Gradinger, Bluhm, and Iken, 2010). Productivity in these OCS waters is reliant upon seasonal shifts in the deposition of organic carbon to the benthic environments through phytoplankton blooms in spring and fall and seasonal melting of sea-ice and subsequent release of ice algae (Gradinger, 2009).

Offshore benthic invertebrate communities can be quite abundant and diverse, often consisting primarily of cnidarians, echinoderms, molluscs, polychaetes, copepods, and amphipods (Darnis, Barber, and Fortier, 2008). Epontic (on ice) organisms are distributed widely in both the Beaufort Sea and Chukchi Sea, consisting primarily of amphipods, euphausiids, nematodes, and ice algae (USDOI, MMS, 2006; Gradinger, Bluhm, and Iken, 2010). Epontic organisms are strongly regulated by availability of light and nutrients, which are in turn dependent upon seasonality and thickness of ice flows and the advection of water masses and the nutrients they carry (Hopcroft et al., 2008).

Pelagic and ice algae planktonic species are important contributors to primary production in the proposed study area by both direct impact (consumption by filter feeding pelagic organisms such as the planktivorous bowhead whale) and indirect impact (release of organic material drifting to the benthos due to reduction of phytoplankton and zooplankton by microbial processes). Pelagic phytoplankton blooms, including concurrent zooplankton and meroplankton populations, tend to occur in early June and late July to August (Hopcroft, Questel, and Clarke-Hopcroft, 2010; Dunton, Schonberg, and McTigue, 2009). Bloom density and duration are dependent upon ice conditions, available light, and nutrients. Pelagic plankton blooms may vary considerably by season and interanually, possibly due to timing of nutrient flows from the Bering Sea (Kirchman et al., 2009). Ice algae potentially extend the season of primary production by 1-3 months past the summer pelagic bloom cycle, with its contribution of organic carbon to the ecosystem in the late summer and early winter dependent upon climatic and weather conditions (Wang, Cota, and Comiso, 2005).

3.2.4. Fish and Essential Fish Habitat

3.2.4.1. Fish

The published information on fish in the Beaufort Sea and Chukchi Sea is mostly on adult fish in the nearshore environment during the open-water season (Craig, 1984; Thorsteinson, Jarvela, and Hale, 1991; Fechhelm and Griffiths, 2001), and generally addresses occurrence, distribution, and abundance. These nearshore studies are important components of understanding the populations of fishes in the project area (Figure 1). Research demonstrates that different species and life stages of many species important as subsistence species or as forage fish use nearshore waters during different periods of the Arctic summer.

In the summer of 2008, a field survey of fish and benthic invertebrates of the western Beaufort Sea was conducted by NOAA, the University of Washington and the University of Alaska. Results from this study (Logerwell et al., 2010; Rand and Logerwell, 2010) pertinent to the ION proposal are summarized here:

- Across all bottom trawls, 6% of all weight was comprised of vertebrate fish species and 94% by weight was invertebrate.
- 36 fish species of fish were caught and identified.
- Arctic cod (*Boreogadus saida*) were the most abundant fish caught during the summer 2008 survey, both by weight and numbers. Walleye pollock (*Theragra chalcogramma*) were present, but primarily as subadults.
- Pollock caught in the Beaufort Sea survey are in densities far lower than in the Bering Sea where they are fished commercially.
- Fifteen species of smaller fish (eelpouts and sculpins) contributed a great number of fish to the total catch of the 2008 survey; however, they did not contribute much in terms of total biomass (weight).

- No specimens of adult or juvenile Pacific salmon species (*Oncorhynchus* sp.) were captured during sampling in the 2008 survey.
- Comparing the results of the NOAA survey data to opportunistic offshore bottom-trawl surveys conducted by Frost and Lowry (1983) in 1976 and 1977, the NOAA authors indicate that there has been a shift in fish species composition and community structure in the central Beaufort Sea over the past three decades.

Fish Distribution and Behavior. Sea water temperature and salinity affect the distribution and behavior of fish in the U.S. Beaufort Sea and eastern U.S. Chukchi Sea. As summer progresses, the nearshore zone becomes more saline due to decreased freshwater input from coastal rivers and streams.

During these summer months, some species (or age groups of a species) move shorewards and feed nearshore on the abundant epibenthic fauna (Craig, 1984). In fall, when diadromous fishes move into freshwater systems to spawn and overwinter, some of these marine fish species remain in the nearshore area to feed (Craig et al., 1985).

As nearshore (<20m) ice thickens in winter, marine fishes probably continue to feed under the ice but eventually depart the area and move further offshore as ice freezes to the bottom to approximately 2 m (6 ft) thick. Seaward of the bottomfast ice, marine fishes continue to feed and reproduce in nearshore waters during winter (Craig, 1984). Arctic cod spawn under the ice between November and February in the U.S. Beaufort (Craig et al., 1982).

There are 23 known families of fish that occur in the Chukchi Sea (Mecklenburg et al., 2007, Mecklenburg, Møller, and Steinke, 2011; Barber et al., 1997; Norcross et al., 2010; Frost and Lowry, 1983; Crawford, 2003). Fish species that are widespread in the Chukchi Sea include Arctic cod, saffron cod, sculpins, sand lance, capelin, flounders, poachers, eelpouts, snailfishes, pink salmon, chum salmon and herring. Small demersal fish are abundant in the Chukchi Sea and their distribution is characterized by sediment type, bottom salinity and bottom temperature. This groups some demersal species together in ecological assemblages in the demersal environment (Norcross et al., 2010).

Similar to the Beaufort Sea, some species, such as saffron cod and capelin, move on and offshore seasonally for spawning using shallower waters for spawning and rearing in autumn and winter. The rivers entering the Chukchi Sea provide estuarine and freshwater habitat for several anadromous species including salmon, Dolly Varden, whitefish, cisco and smelt.

Arctic cod, saffron cod, and the five species of Pacific salmon that occur in the Beaufort Sea and Chukchi Sea are discussed further under the Essential Fish Habitat (EFH) section.

3.2.4.2. Essential Fish Habitat

Two Fishery Management Plans in Alaska apply to the area under consideration in this EA: the Fishery Management Plan for Fish Resources of the Arctic Management Area (NPFMC, 2009) (Arctic FMP); and the Salmon Fishery Management Plan for Coastal Alaska (NPFMC, 1990). Essential Fish Habitat (EFH) overlaps with the area of Proposed Action for the following species and life stages: Arctic cod (*Boreogadus saida*) (adult and late juvenile); the five species of Pacific salmon (*Oncorhynchus* sp.) (adult and late juvenile) and saffron cod (*Eleginus gracilis*) (adult and late juvenile). The Arctic cod and salmon EFH overlap the entire Proposed Action area; saffron cod EFH exists in the south western portion of the proposed survey lines. The Proposed Action does not overlap with Opilio crab EFH (described in the Arctic FMP) or Pacific salmon eggs and larvae freshwater EFH. EFH for the Beaufort Sea and Chukchi Sea are listed in Table 3, and described below. The full description of EFH for these species can be found on the North Pacific Fishery Management Council website (NPFMC, 2012).

Table 3. Target species and life stage for which EFH has been described for the Beaufort Sea and Chukchi Seas

EFH Species	Sea	Eggs EFH	Larvae EFH	Late Juvenile EFH	Adults EFH
Arctic cod (*Boreogadus saida*),	Beaufort, Chukchi			X	X
Saffron Cod (*Eleginus gracilis*)	Beaufort, Chukchi			X	X
Pacific Salmon (5 species)	Beaufort, Chukchi	X	X	X	X
Opilio Crab (*Chionoecetes opilio*)	Chukchi	X		X	X

Arctic Cod. Arctic cod is widely distributed throughout the U.S. Arctic, including the pelagic, demersal, and nearshore environments of the Beaufort Sea and Chukchi Sea, depending on time of year and life history stage. The absolute numbers of Arctic cod and their biomass is one of the highest of any finfish in the region (Logerwell et al., 2010; Frost and Lowry, 1983). Results of a 2008 NOAA survey showed that Arctic cod were the most abundant fin-fish caught in a summer survey in the Central Beaufort Sea, both by weight and absolute numbers. Pelagic yearling and older Arctic cod were most abundant at the continental shelf-break (100 m, 328 ft); pelagic young-of-year were most commonly found inshore (Logerwell et al., 2010). Frost and Lowry (1983) found smaller Arctic cod more often in water less than 100 m deep. Craig et al. (1982) found adult and juvenile Arctic cod in shallow nearshore waters (1-12 m) in the Beaufort Sea in winter and summer. Arctic cod were identified in high densities using acoustic measurements in the bottom of Barrow Canyon at depths of 200-250 m and along the steep canyon walls between 125-and 200 m during a research cruise from early September to early October 2002 (Crawford, 2003).

Arctic cod are associated with sea ice, using it at various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Amphipods on the underside of ice are an important food source for Arctic cod (Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside-ice may provide preferred habitat for Arctic cod to avoid predators (Cross, 1982). Gradinger and Bluhm (2004) and Lonne and Gulliksen (1989) observed and photographed Arctic cod in summer months using ice crevices and cracks on the underside of textured ice floes for escape and shelter.

Arctic cod also inhabit offshore and nearshore areas without ice during warmer times of year (Bradstreet and Cross, 1982; Bradstreet, 1982; Cross, 1982; Crawford and Jorgenson, 1993; Gradinger and Bluhm, 2004). Copepods and amphipods are common prey for Arctic cod in open water (Lowry and Frost, 1981; Benoit et al., 2010).

Arctic cod move and feed in different groupings – as dispersed individuals, in schools, and in huge shoals. These distribution patterns appear to be dependent on several interacting factors including season, presence or absence of ice, salinity, water temperature, surface wind, currents, and underside texture of ice. Inter-annual variation also plays a role in the pattern of distributions. Welch, Crawford, and Hop (1993) documented huge, dense schools of Arctic cod pooling in deep basins in bays and inlets during open-water periods in the Canadian Beaufort Sea. Benoit et al. (2010) found daily vertical migration of Arctic cod in the Eastern Canadian Beaufort was dependent on daylight length and presence of prey; by May, in prolonged daylight, vertical migration stopped and Arctic cod increased their schooling and feeding activity.

Arctic cod migrate between offshore and onshore areas for seasonal spawning. They spawn under the ice during winter (Craig et al., 1982; Craig, 1984; Bradstreet et al., 1986). Arctic cod eggs and larvae are pelagic.

Ringed seals, ribbon seals, spotted seals, beluga whales and several seabird species depend heavily on Arctic cod (Bradstreet, 1982; Bradstreet and Cross, 1982). Most notably, it is the ice seals that have been shown to exhibit a heavy reliance upon Arctic cod during the winter (Bluhm and Gradinger, 2008; Dehn et al., 2007; Divoky, 1984; Frost and Lowry, 1984; Welch, Crawford, and Hop, 1993). The biomass of Arctic cod (as both predator and prey) transfers energy throughout the food web (Crawford and Jorgenson, 1996; Bradstreet et al., 1986). The abundance, wide distribution and the role in the food web of Arctic cod in the Beaufort Sea makes this species important in the ecosystem of the U.S. Beaufort Sea and Chukchi Sea.

Saffron Cod. Saffron cod occur in the Chukchi Sea primarily in nearshore waters. Unlike Arctic cod, they do not specifically associate with ice. Saffron cod move seasonally from summertime feeding offshore to inshore for spawning. They enter coastal waters and tide-influenced riverine environments. Adults and juveniles forage on the epibenthos, opportunistically taking small crustaceans and fish (Froese and Pauly, 2010). Four specimens of saffron cod were caught in the western Beaufort Sea in bottom trawls in the summer of 2008 during a NOAA fish survey (Logerwell et al., 2010). During this research cruise, saffron cod accounted for one of the lowest total number and total weight of all fish species captured.

Pacific Salmon. Pacific salmon occur in the Beaufort Sea (Craig and Haldorson, 1986; Babaluk et al., 2000). Pink and chum salmon are the most common of the five species. In 1986, Craig and Haldorson summarized the distribution of Pacific salmon in Arctic Alaska:

> All five North American Pacific salmon species occur in small numbers in Arctic waters, but only pink and chum salmon appear to have viable populations north of Point Hope, Alaska. Pink salmon are the most common species and constitute 85% of salmon caught in biological surveys. Pink salmon apparently have small runs in eight Arctic drainages, while chum salmon may have small runs in six. Arctic pink salmon are smaller in size than individuals to the south but have similar meristic characteristics. It is likely that minimal use of freshwater habitats by pink and chum salmon has allowed them to colonize characteristically cold Arctic rivers. (Craig and Haldorson, 1986)

Craig and Haldorson (1986) identified seventeen water bodies (rivers, streams, lagoons) between Point Hope and the Alaska-Canada border that apparently support small populations of pink and chum salmon. A few isolated spawning stocks of chum and pink salmon occur in the Beaufort Sea area, primarily the Sagavanirktok and Colville rivers. Records of individual king, coho, and sockeye salmon were also identified in these waterbodies, which Craig and Haldorson attributed as probable strays. In 2000, Babaluk et al. reported capture records of sockeye, pink, chum and coho in the western Canadian Arctic. Eight of the sockeye salmon caught in a Banks Island subsistence fishery were sexually mature. These records documented substantial extensions of the previously known ranges for Pacific salmon in the Canadian Arctic. Updated fish count records are available at the Alaska Department of Fish and Game website (ADF&G, 2012). In the marine environment, adult pink and chum salmon in the U.S. Beaufort Sea and Chukchi Sea can be found down to 200 m (660 ft) depth. Logerwell et al., (2010) did not capture salmon in bottom and midwater trawls in their western Beaufort Sea pilot offshore survey in the summer of 2008. Substantial populations of salmon may have a difficult time establishing and persisting in the Arctic, most likely because of the limitation of freshwater spawning habitats which freeze over in winter and are not suitable for overwintering eggs and young (Craig, 1989; Fechhelm and Griffiths, 2001).

3.2.5. Marine and Coastal Birds

Most marine birds that occur in the Beaufort Sea and Chukchi Sea are there during the open-water season. Arrival times usually coincide with the formation of leads during spring migration to coastal breeding areas. Spring migration for most species takes place between late March and late May.

Some birds that breed on the North Slope migrate to or through the Proposed Action area (Figure 1) twice each year. Some marine and coastal birds may breed outside the project area, but spend time in the Chukchi Sea and Beaufort Sea after breeding or during their non-breeding seasons. Departure times from the Beaufort Sea for the fall and winter vary between species and often by sex within the same species, but most marine and coastal birds will have moved out of the Beaufort Sea by late October before the formation of sea ice.

Full descriptions of the most important marine and coastal bird species in the Beaufort Sea and Chukchi Sea were provided in the Beaufort Sea Multiple-Sale EIS, Lease Sale 193 and Seismic Surveying EIS, and the Lease Sale 193 SEIS. These descriptions are summarized and updated with site-specific information below. Recent information, especially from the Klondike and Burger prospects (over 50 miles offshore in the Chukchi Sea), is consistent with previous descriptions, and existing information is sufficient to fully evaluate the potential effects of the two alternatives.

Descriptions of Species or Species Groups

Marine and coastal birds potentially affected by this action can be grouped according to certain aspects of their life-history or status: ESA-listed birds, loons and waterfowl, and seabirds (Table 4). The timing and specific location of the Proposed Action influence which birds could be affected. Birds listed as threatened or candidate (four species) or abundant in the Proposed Action area (five species) have the greatest potential for adverse effects and are described further. These nine species were carried forward to the Environmental Consequences Section 4.2.5.

Table 4. Marine and coastal birds most likely to be affected by the Proposed Action.

Species	Threatened or candidate species	Abundant in offshore Proposed Action area	Carried forward under effects analysis
ESA-Listed Species			
Spectacled Eider	Yes	No	Yes
Steller's Eider	Yes	No	Yes
Kittlitz's Murrelet	Yes	No	Yes
Yellow-billed Loon	Yes	No	Yes
Abundant Species			
Long-tailed Duck	No	Yes	Yes
Common Eider	No	Yes	Yes
King Eider	No	Yes	Yes
Northern Fulmar	No	Yes	Yes
Short-tailed Shearwater	No	Yes	Yes

Source: USDOI MMS (2003, 2007a), USDOI BOEMRE (2011)

ESA-listed Birds

The distribution, abundance, and legal status of birds designated as threatened or listed as candidate species under the ESA are most recently described in the ESA Section 7 Biological Opinion (USDOI, FWS, 2012). These include the Steller’s eider (*Polysticta stelleri*; threatened), the spectacled eider (*Somateria fisheri*; threatened), the Kittlitz’s murrelet (*Brachyramphus brevirostris*; candidate species), and the yellow-billed loon (*Gavia adamsii*; candidate species) and are often collectively referred to as ESA-listed birds. Because of their special status under ESA, the potential effects to all four species are analyzed in the Environmental Consequences section (Section 4.2.5).

Spectacled Eider. The North Slope spectacled eider population seems to be stable, at least since the initiation of aerial surveys of the Arctic Coastal Plain (ACP) in 1992 (Larned, Stehn, and Platte, 2009). Spectacled eiders breed in low densities across the Alaskan ACP east to about the Shaviovik River. Males leave the breeding grounds along the ACP for the ocean around mid - to late June at the onset of incubation by female eiders. Males are followed by females whose nests fail, and finally by successful breeding females and young birds in August and September. Female spectacled eiders migrate west along the Alaska coast as far as 40 km offshore. Most spectacled eiders will have migrated from the Beaufort Sea by mid-October, although small numbers of spectacled eiders could be encountered in nearshore locations of the Beaufort Sea.

Steller’s Eider. A small number of Steller’s eiders breed on the ACP of Alaska, most conspicuously near Barrow. Steller’s eiders are rare east of Barrow to the Prudhoe Bay area. They are even rarer as the season progresses due to molt migration, failed breeding, etc. As with the more common spectacled eider, these birds move to nearshore coastal waters after their breeding season. Few if any Steller’s eiders would likely be in the southern Beaufort Sea during or after the open-water season.

Yellow-billed Loon. The yellow-billed loon is relatively rare in the U.S. Arctic region (North, 1994). Dau and Bollinger (2009) reported an average of fewer than 50 yellow-billed loons during late-June surveys of the coast and barrier islands between Omalik Lagoon and the Canadian Border (2005-2009). Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs because some of the 3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons (presumably juvenile nonbreeders) that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al., 2005). There may be approximately 1,500 yellow-billed loons, presumably non-breeding adults and immatures, in near shore marine waters or in large rivers during the breeding season.

Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes. Breeding yellow-billed loons typically remain on their lakes until young are fledged.

Most yellow-billed loons from the ACP have moved into nearshore coastal waters by September. In addition, approximately 8,000 yellow-billed loons from the Canadian Arctic travel across the Chukchi Sea during spring and fall migration between Canada and wintering grounds in eastern Asia (Schmutz et al., 2010). Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Rizzolo and Schmutz, 2010). Yellow-billed loons were observed at the Burger Prospect during seabird surveys in 2008 and 2009 (Gall and Day, 2011). Most sightings of yellow-billed loons represented low numbers of birds during the survey period; however, 24 were observed during the early fall period in 2009. No yellow-billed loons were observed during seabird surveys in the Chukchi Sea in late August and early September 2011 (Kuletz, 2011a). Low numbers, patchy distributions, and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than species that are more abundant, widely distributed, and able to exploit a greater diversity of habitats.

Kittlitz’s Murrelet. This species may nest as far north as Cape Beaufort. Breeding along the Arctic Coastal Plain is unlikely due to lack of suitable habitat. Kittlitz’s murrelets have been observed on an infrequent basis in the Chukchi Sea as far north and east as Point Barrow, but there appears to be a great deal of annual variation in their occurrence. Small numbers of Kittlitz’s murrelets were recorded during late fall seabird surveys in the Klondike and Burger Prospect areas in 2009 and 2010, but none were observed in 2008 (Gall and Day, 2011). Murrelet foraging areas occur in the Chukchi Sea (Day et al. 2011). Murrelet foraging areas may occur offshore near Barrow.

Other Birds

Loons and Waterfowl. The Pacific loon (*Gavia pacifica*), red-throated loon (*G. stellata*), Pacific brant (*Branta bernicla nigricans*), lesser snow goose (*Chen caerulescens caerulescens*), greater white-fronted goose (*Anser albifrons frontalis*), and tundra swan (*Cygnus columbianus*) occur in nearshore coastal waters of the Beaufort Sea and Chukchi Sea (USDOI MMS (2003, 2007a); USDOI BOEMRE (2011)). Waterfowl species that are more abundant and occur in more offshore areas of the Beaufort Sea and Chukchi Sea include the long-tailed duck (*Clangula hyemalis*), the common eider (*Somateria mollissima*), and the king eider (*Somateria spectabilis*) and are described below.

Long-Tailed Duck. The long-tailed duck population has decreased considerably since 1989, but it remains a common species in the Beaufort Sea and Chukchi Sea during the open-water period (Mallek, Platte, and Stehn, 2007). Many long-tailed ducks molt in the lagoons along the Beaufort Sea coast. In late June and early July, most male and nonbreeding female long-tailed ducks migrate to coastal molting areas where they are flightless for a 3- to 4-week period. Breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall. While most long-tailed ducks migrate within 45 km (28 mi) of shore, infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987).

The molt is an energetically costly time, and long-tailed ducks have abundant food resources in the shallow water lagoons (Flint et al., 2003). During the molt, long-tailed ducks tend to stay in or near the lagoons, especially near passes between lagoons and the open ocean (Johnson, Frost, and Lowry, 1992; Johnson, Wiggins, and Wainwright, 1992; Kinney, 1985).

The long-tailed duck is a common species in the Chukchi Sea after the first week of September until late October. Many long-tailed ducks molt in Kasegaluk Lagoon and Peard Bay on the Chukchi Sea coast. Molting long-tailed ducks tend to stay in or near the lagoons, feeding heavily in passes between barrier islands. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 7,500 long-tailed ducks, with about two-thirds of these associated with mainland habitats (Dau and Bollinger, 2009). Fewer than 70 long-tailed ducks were observed during any survey period at the Burger Prospect during seabird surveys (2008-2010) and most survey periods observed no long-tailed ducks (Gall and Day, 2011).

Common Eider. Common eiders nest on barrier islands or spits along the Beaufort Sea coast. Dau and Larned (2005) observed 1,819 common eiders along the Beaufort Sea coast with 652 on barrier islands and 1,167 on the mainland. Dau and Larned (2007) observed a total of 1,936 common eiders. Of these, 871 were along the Beaufort Sea coast with 423 along the barrier islands and 448 along the mainland. The highest concentrations were on survey segments on both sides of Kaktovik. In 2007, total birds and indicated breeding pairs were down 37.6% and 44.0%, respectively, from 2006 counts of 3,102 birds and 1,207 pairs. Total birds and indicated breeding pairs in 2007 were down 30.0 and 27.8%, respectively, from the 1999-2006 averages of 2,766+885 (1 standard deviation, range 1,353-4,449) birds and 937+264 (1 standard deviation, range 572-1,340) pairs (Dau and Larned, 2007).

After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987). When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 48 km (29 mi) from shore. Most males are out of the Beaufort Sea by late August or early September, and most females were gone by late October or early November. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September.

The common eider population in the Beaufort Sea declined by 53% between 1976 and 1996 (Suydam et al., 2000). Common eiders were surveyed in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point by Fischer and Larned (2004) during summers in 1999-2001. In general, common eiders were concentrated in waters <10 m (<33 ft), with the highest densities occurring in segments between Oliktok Point and Prudhoe Bay and between Tigvariak Island and Brownlow Point. Common eiders were most commonly associated with barrier islands in these segments, becoming less commonly observed up to 50 km seaward. Common eider densities were highest in areas of low ice cover.

Fischer and Larned (2004) concluded that because eider densities did not vary between summer months, the eiders they observed near barrier islands were local breeders rather than molt or fall migrants. This is consistent with Petersen and Flint (2002), who showed that satellite-tagged common eider hens remained in shallow waters close to their breeding sites through September.

Male common eiders begin moving out of the Beaufort Sea beginning in late June. Most males are out by late August or early September, and most females were gone by late October or early November. Most common eiders migrate within 48 km of the coast when traveling west along the Beaufort Sea.

Beginning in late June, postbreeding male common eiders begin moving towards molting areas in the Chukchi Sea; by late August, most common eiders in the Chukchi Sea are molting males. Most breeding female common eiders and hatch-year birds begin to migrate to molt locations in late August and September. Common molt areas in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne. Kasegaluk Lagoon and Peard Bay also are important locations for molting and during migration. After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore. Less than 10 common eiders were observed at the Burger, Klondike, or Statoil prospects during seabird surveys in 2008, 2009, and 2010 (Gall and Day, 2011).

King Eider. Most king eiders begin to arrive in the Beaufort Sea by the middle of May. Arrival times in the Beaufort Sea are dependent upon the location and timing of offshore leads along the Chukchi Sea (Barry, 1986). Most king eiders nesting on the North Slope between Icy Cape and the western boundary of ANWR nested in three general areas: between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake and a large area near Atqasuk (Larned, Stehn, and Platte, 2006). Dau and Larned (2005, 2006, 2007, 2008) surveyed the Chukchi Sea and Beaufort Sea coastlines and found 810, 3,048, 1,621, and 2,227 king eiders in 2005, 2006, 2007, and 2008, respectively.

The king eider population in the Beaufort Sea appeared to remain stable between 1953 and 1976 but declined by 56% between 1976 and 1996 (Suydam et al., 2000). Fischer and Larned (2004) surveyed king eiders in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point during summers in 1999 and 2001. King eiders were the second most abundant species counted during the survey periods. King eider densities varied according to water depth, offshore distance, and percent of ice cover. Large flocks of king eiders concentrated in the mid-depth (10-20 m [33-66 ft]) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m (>33 ft) deep but were found in the shallow (<10 m [<33 ft]) and mid-depth zone in July 2001. King eiders were unique among species surveyed by occurring in higher densities in low (31%) and moderate (31-60%) ice cover (Fischer and Larned, 2004).

Satellite telemetry was used to determine that most king eiders spent more than 2 weeks staging offshore in the Beaufort Sea prior to fall migration (Phillips, 2005; Powell et al., 2005). Female king eiders may need to remain in the Beaufort Sea longer than males to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km offshore; however, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km (>31 mi) offshore (Phillips, 2005).

Many post-breeding male king eiders move to staging areas along the Chukchi Sea in mid- to late July. Ledyard Bay and Peard Bay appear to be particularly important to molting and migrating king eiders (Oppel, Dickson, and Powell, 2009). Hundreds of thousands of king eiders move through the Chukchi Sea during their migration from breeding grounds in eastern Canada. No more than two king eiders were observed during any seabird survey period in 2008 or 2010 at the Klondike and Burger prospects and no king eiders were observed in 2009 (Gall and Day, 2011).

Seabirds

The common murre (*Uria aalge*), thick-billed murre (*U. lomvia*), tufted puffin (*Fratercula cirrhata*), horned puffin (*F. corniculata*), black-legged kittiwake (Rissa tridactyla), black guillemot (*Cepphus grylle*), Ross' gull (*Rhodostethia rosea*), ivory gull (*Pagophila eburnea*), Arctic tern (*Sterna paradisaea*), pomarine jaeger (*S. pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), and glaucous gull (*Larus hyperboreus*) occur in the Chukchi Sea and Beaufort Sea (USDOI MMS (2003, 2007a); USDOI, BOEMRE (2011b). Seabird species that are more abundant and occur in offshore areas include the northern fulmar (*Fulmarus glacialis*) and the short-tailed shearwater (*Puffinus tenuirostris*) and are described below.

Northern Fulmar. Fulmars do not breed in the Arctic region, and those observed during the summer are nonbreeders or failed breeders from southern areas. Fulmars are most numerous from late August to mid-September. Divoky (1987) estimated 45,000 northern fulmars in pelagic waters of the southern Chukchi Sea during late August to mid-September. Flocks totaling in the low hundreds were observed during the late summer and early fall around the Klondike and Burger prospects during seabird surveys in 2008, 2009, and 2010 (Gall and Day, 2011).

Short-Tailed Shearwater. Shearwaters do not breed in the Arctic region. These birds breed in the Southern Hemisphere. At northern latitudes, short-tailed shearwaters likely forage at highly productive patches of euphausiids and amphipods. Divoky (1987) reported short-tailed shearwaters north of Barrow and into Arctic Canada, depending on the presence of sea ice. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987).

Gall and Day (2011) suggested that the shearwaters can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. For example, Kuletz (2011b) reported a single flock numbering over 15,000 short-tailed shearwaters in the western Beaufort Sea in late August–early September, 2011. Kuletz (2011a) reported over 4,000 shearwaters during a seabird survey in the Chukchi Sea in late August – early September 2011 (the most abundant species reported), with many flocks numbering between 150-300 birds. Similarly, flocks totaling in the low hundreds were observed during the early fall around the Klondike, Burger, and Statoil prospects during seabird surveys in 2008, 2009, and 2010 (Gall and Day, 2011); however, during the early fall period in 2009, almost 12,000 short-tailed shearwaters were observed near the Klondike Prospect.

3.2.6. Marine Mammals

The marine mammals that are most likely to occur in the Proposed Action area are beluga whales, bowhead whales, Pacific walrus, ringed seals, bearded seals, and polar bears. Spotted seals and ribbon seals may occur in the project area in small numbers. Whales and ice seals are managed by the NMFS. The bowhead whale is listed as endangered under the ESA, and both ringed and bearded seals have been proposed for listing under the ESA. Pacific walrus and polar bear are managed by the FWS. The polar bear is listed as threatened under the ESA, and the Pacific walrus is a candidate species.

Most species will occur in low densities and encounters would be most common within 100 km of shore where waters are less than 200 m deep or along the shelf break. Additional information on species stocks occurring within the Beaufort Sea and Chukchi Sea, their population size and ESA status is available in Table 5. The most widely distributed marine mammals within the Proposed Action area in fall are expected to be the beluga whales, bearded seals, ringed seals, and polar bears. During the open-water season, bowhead whales, bearded seals and walrus commonly occur in the Proposed Action area. By October/November most species have historically migrated west and south into the southern Chukchi Sea and Bering Sea. Recent tagging information indicates that bowhead whales may remain in the Chukchi Sea later in the fall than was previously believed and occur in small numbers in the Chukchi Sea throughout the winter (Quakenbush et al., 2010).

Table 5. Habitat, abundance, and ESA status of marine mammals occurring within the Proposed Action area.

Species	Stock	Habitat	Stock Size	ESA Status
Beluga Whale	E. Chukchi Sea	Open leads and polynyas, coastal areas, ice edges	Min. est. 3,710	Not listed
Beluga Whale	Beaufort Sea	Open leads and polynyas, coastal areas, ice edges	Min. est. 32,453	Not listed
Beluga Whale	E. Bering Sea	Open leads and polynyas, coastal areas, ice edges	Min. est. 20,231	Not listed
Narwhal	Unidentified stock	Offshore, ice edge, heavy pack ice, leads and channels	Rare in Chukchi/ U. S. Beaufort Sea	Not listed
Killer Whale	Offshore	Open water	No est. available. Rare in U.S. Chukchi Sea / Beaufort Sea	Not listed
Harbor Porpoise	Bering Sea	Coastal waters <100m depth, Chukchi only	Min. est. 40,039	Not listed
Bowhead Whale	Western Arctic	Ice edge, polynyas and leads, open water	Min. est. 9,472	Endangered
Gray Whale	Eastern North Pacific	Open water, coastal waters	Min. est. 18,017	Not listed
Fin Whale	Northeast Pacific	Open water	Min. est. 5,700 Rare in Chukchi Sea	Endangered
Minke Whale	Alaska	Open Water	No est. available Rare in Chukchi Sea	Not listed
Humpback Whale	Central North Pacific	Open Water	Min. est. 5,833 Rare in Chukchi Sea	Endangered
Bearded Seal	Alaska	Pack ice and open water	No estimate available	Proposed for listing
Spotted Seal	Alaska	Pack ice, ice edge and coastal habitat	No estimate available	Arctic population not listed
Ringed Seal	Alaska	Nearshore land fast and pack ice, Interior pack ice	No estimate available	Proposed for listing
Ribbon Seal	Alaska	Open water and pack ice	Est. 49,000	Not listed
Pacific Walrus	Bering Sea and Chukchi Sea	Pack ice and coastal haulouts	Min. est. 129,000	Candidate
Polar Bear	S. Beaufort Sea / N. Beaufort Sea / Chukchi Sea / Bering Sea	Coastal, barrier islands, pack ice	Estimates. 1,526+1,200+2,000=4,726	Threatened

Source: Allen and Angliss, May 2012.

Seven cetacean species— narwhal, killer whale, harbor porpoise, minke whale, fin whale, gray whale, and humpback whale —could occur in the project area during the open-water period. However, interactions with these species are unlikely due to very low documented occurrence rates, and the likelihood that they will have migrated out of the Beaufort Sea and northern Chukchi Sea by October or November. Recent evidence from monitoring during seismic survey activities during the 2006-2009 open-water seasons in the Chukchi Sea and Beaufort Sea suggests that harbor porpoise and minke whale, which have been considered uncommon or rare in the Chukchi Sea and Beaufort Sea, may be increasing in numbers in these areas during the open-water season (Funk et al., 2009). Small numbers of killer whales have also been recorded during industry surveys, along with a few sightings of fin and humpback whales. The narwhal occurs in Canadian waters, but is rarely seen and considered extralimital in the Beaufort Sea. These seven species are not discussed further in this EA because of their scarcity in the analysis area.

Additional pinniped species that could be encountered during the proposed geophysical survey include spotted and ribbon seals, and Pacific walrus. Spotted seals are more abundant in the Chukchi Sea and typically occur in small numbers in the Beaufort Sea. The ribbon seal is uncommon in the northern Chukchi Sea with rare sightings in the Beaufort Sea. Pacific walrus, though common in the Chukchi Sea in summer and fall, are uncommon in the Chukchi Sea during late fall and winter, and uncommon in the Beaufort Sea. All three of these species move southward with the advancing ice edge in fall. Other pinniped species are unlikely to be encountered during the Proposed Action and are not discussed further in this EA.

3.2.6.1. ESA Listed Marine Mammals

Polar Bear. Polar bears (*Ursus maritimus*) occur on the pack and shorefast ice, along the coast, and on barrier islands. They have occasionally been observed in open-water in the Beaufort Sea and Chukchi Sea, transiting between pack ice and shore. The polar bear is listed as threatened under the ESA throughout its range. Polar bear habitat use and distribution may reflect prey availability, time allocated for hunting prey and the use of retreat habitats (Durner et al., 2004). Modeling of polar bear ice habitat selection indicates that shallow-water areas where different ice types intersect are preferred (Durner et al., 2004, 2007). The FWS established critical habitat for the polar bear on December 7, 2010 (74 FR 76058). Three different critical habitat units were identified: sea ice, terrestrial denning, and barrier island habitats.

Bowhead Whale. Bowhead whales occur seasonally within the Beaufort Sea and Chukchi Sea. No critical habitat has been designated for this species. This stock of bowheads is currently referred to as the Western Arctic stock (by NMFS) or as the Bering-Chukchi-Beaufort Seas stock (by the International Whaling Commission). Bowheads are currently increasing in abundance at a rate of approximately 3.2% per year. They are present in the eastern Beaufort Sea throughout the summer (Moore, Clarke, and Ljungblad, 1989; Moore and Reeves, 1993; Moore et al., 2000; Moore et al., 2002). In the autumn, bowheads generally move from the Beaufort Sea westward toward and across the Chukchi Sea as they migrate back to the Chukotka Peninsula waters and the Bering Sea wintering areas from about mid-September through November (Moore et al., 1995). Some bowheads may remain in or return to the Chukchi Sea throughout the summer and fall. The Western Arctic stock of bowhead whales overwinter in the central and western Bering Sea.

Bearded Seal. Bearded seals are the largest of the northern phocids, and have a circumpolar distribution. During the open-water period, they generally occur over relatively shallow depths, usually preferring areas no deeper than 200 m. During summer, many migrant bearded seals return to the Chukchi Sea and Beaufort Sea, only to return to the Bering Sea as ice conditions develop during fall. A small proportion of bearded seals remain in the Chukchi Sea and Beaufort Sea as year-round residents, either using shear leads and polynyas for foraging, or sometimes creating and maintaining breathing holes in pack ice similar to ringed seals. Bearded seals avoid zones of shorefast ice, preferring pack ice. Most bearded seals are found in the Bering Sea and Chukchi Sea and are predominantly benthic feeders, feeding on a variety of invertebrates (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Stirling, 1997).

Ringed Seal. Ringed seals are considerably higher in number than other seal species in the Beaufort Sea and Chukchi Sea, particularly during the winter and spring (Burns, 1970). Ringed seals have the unique ability to maintain breathing holes in thick ice and zones of shorefast ice. In early summer the highest densities of ringed seals are found in nearshore and pack ice. During the open-water season, ringed seals are dispersed throughout the open water. The seal most likely to be encountered in the Proposed Action area during the proposed survey period is the ringed seal.

Pacific Walrus. The Pacific walrus population is generally associated with moving pack ice, year-round. Pacific walruses winter in the Bering Sea and most Pacific walruses summer in the northeastern Chukchi Sea and into the westernmost part of the Beaufort Sea. Though capable of diving to deeper depths, Pacific walruses are usually found in waters ≤ 100 m deep, possibly because of higher productivity of their benthic foods in shallower water (Fay, 1982). On February 10, 2011, the FWS completed a status review of the Pacific walrus and determined that although listing the species was warranted, the listing was precluded by other higher priority actions (76 FR 7634), consequently the Pacific walrus is now designated a candidate species under the ESA.

3.2.6.2. Other Marine Mammal Populations

Ribbon Seal. Ribbon seals range northward from the Bering Sea into the Chukchi Sea and western Beaufort Sea. During the breeding and molting periods from about mid-March through June, ribbon seals are closely associated with pack ice, particularly in the Bering Sea and in the Sea of Okhotsk. Ribbon seals spend the rest of the year in open water foraging for cephalopods, pollock, cod and other prey items (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Stirling, 1997; Boveng et al., 2009).

Spotted Seal. The Bering Sea Distinct Population Segment (DPS) of spotted seals inhabit the Bering Sea and Chukchi Sea as well as the more southern portion of the Beaufort Sea. Spotted seals occur in lower numbers in the Beaufort Sea than in the Chukchi Sea, and likewise their Beaufort Sea haulouts are much smaller than those along the Chukchi Sea coastline. Spotted seals are associated with sea ice from late fall through spring, especially during the breeding and molting seasons, which occur in April through June. During the remainder of the year, spotted seals rest on sea ice or at coastal haul outs between foraging trips. Spotted seals prey upon a wide variety of fish and invertebrate species and typically migrate south from the Chukchi Sea and into the Bering Sea in October or November (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Stirling, 1997; Boveng et al., 2009).

Beluga Whale. The Beaufort Sea and Chukchi Sea beluga whale stocks winter in the Bering Sea and summer in the Beaufort Sea and Chukchi Sea, migrating around western and northern Alaska along the spring lead system in April and May (Richard, Martin, and Orr, 2001; Angliss and Outlaw, 2005). Belugas generally are associated with ice and relatively deep water throughout the summer and autumn. During late summer and autumn, most belugas migrate westward far offshore near the continental shelf break and the pack ice (Frost, Lowry and Burns, 1988; Hazard, 1988; Clarke, Moore, and Johnson, 1993; Miller et al., 1999).

Moore (2000) and Moore, DeMaster, and Dayton (2000) suggested that beluga whales select deeper water near the continental shelf break independent of ice cover. During the westward migration in late summer and autumn, small numbers of belugas are sometimes seen near the Beaufort Sea coast of Alaska (e.g., Johnson, 1979). Christie, Lyons, and Koski (2009) reported higher beluga sighting rates at locations >60 km offshore than at locations nearer shore during aerial surveys in the U. S. Beaufort Sea in 2006-2008. Belugas were not recorded during Arctic cruises by the U.S. Coast Guard (USCG) Cutter Healy in 2005 or 2006 (Haley, 2006; Haley and Ireland 2006) however, this could be due to avoidance of the icebreaker as beluga are known to avoid icebreakers actively engaged in breaking ice by as much as 50 km (Erbe and Farmer, 2000).

Gray Whale. Gray whales occur regularly in continental shelf waters along the Chukchi Sea coast in summer and to a lesser extent along the Beaufort Sea coast. Gray whales return annually to primary feeding areas in the northern Bering Sea and Chukchi Sea during the open-water season. However, in recent years, more gray whales have been observed entering the Beaufort Sea east of Point Barrow, especially in the late summer and autumn. Gray whales feed on amphipods, polychaetes, other invertebrates and small fish found in sediment on the seafloor, and prefer areas of little or no ice cover. Gray whale feeding habitat in the northern Chukchi Sea appears limited to shoal and coastal waters and their selection of shoal and coastal habitat is greatest in the summer (Allen and Angliss, 2010).

3.2.7. Subsistence Activities, Employment, Public Health, and Environmental Justice

Subsistence activities are a central element in the North Slope Borough (NSB) socioeconomic system. The socioeconomic composition of the NSB is referred to as a “mixed economy,” comprised of traditional subsistence activities and income from employment as well as State, Federal and Native corporation services and jurisdictions with unique benefits and pressures that are a part of life in the Arctic. The following sections of the EA address specific components of these resources that are most relevant to the coastal communities of Kaktovik, Nuiqsut, and Barrow: subsistence, employment, and public health.

The Proposed Action does not extend into the subsistence use areas of Wainwright, Point Lay or Point Hope and these villages are not discussed. Two seismic survey lines would extend west of Point Barrow into the Chukchi Sea, but the Proposed Action would occur long after Barrow's fall subsistence bowhead whaling season had concluded. The Proposed Action is not expected to affect subsistence activities, employment, public health, or environmental justice in the Chukchi Sea, and the subsistence activities in the Chukchi Sea are not carried forward to further analysis.

3.2.7.1. Subsistence Activities

Subsistence activities are assigned the highest cultural values by the Iñupiat of the North Slope and provide a sense of identity in addition to being an important economic pursuit. Subsistence is viewed by Alaska Natives not just as an activity that is imbedded in the culture; it is viewed as the very culture itself (Wheeler and Thornton, 2005).

Bowhead whales are hunted for subsistence by the Iñupiat under conventions established by the International Whaling Commission (IWC). Traditional whale hunting occurs every spring and fall. Although bowhead whaling traditions are unquestionably important, harvest of other wild resources, including caribou, fish, birds, and other marine mammals also are important to the local inhabitants for variety in the diet and nutritional needs if few or no bowhead whales are taken (Applied Sociocultural Research, 2010; USDOI, BOEMRE, 2011a).

Subsistence Communities

This discussion focuses on the subsistence activities, related subsistence resources, and subsistence distribution levels that generally occur during the period of the Proposed Action. ION proposes beginning sound source measurements in the East Survey Area in the Beaufort Sea no earlier than October 17, after Kaktovik and Nuiqsut have completed their bowhead whale hunt. ION will not begin surveying the western Beaufort Sea or Chukchi Sea until after Barrow has completed the fall bowhead whale hunt (ION, 2012b).

Kaktovik. In late autumn-early winter after the bowhead whale hunt, Kaktovik residents direct their subsistence efforts inland to hunt caribou, moose, and Dall sheep, trap furbearers, and fish. In the fall/winter, the people fish inland under river ice using nets, mainly catching Dolly Varden, broad whitefish, burbot, and some lake trout (Impact Assessment Inc, 1990a; Pedersen and Linn, 2005; Pedersen and Coffing, 1984; SRB&A, 2010).

Kaktovik’s subsistence harvest areas are depicted in detail in the MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 61-110) and are described in detail in the 2012 Shell Camden Bay EP EA (USDOI, BOEMRE, 2011a).

Nuiqsut. In late autumn-early winter after the bowhead whale hunt, Nuiqsut residents direct their subsistence efforts inland to hunt caribou and moose, trap furbearers, and fish. By this time, the caribou have migrated away from the coast. In a typical year, Nuiqsut residents expend their greatest effort fishing under the ice of the river channels to catch Arctic Cisco and broad whitefish. It is during this season that people begin harvesting burbot (Impact Assessment Inc., 1990b; SRB&A, 2010).

Nuiqsut's subsistence harvest areas are depicted in detail in MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 11-162) and are described in detail in the 2012 Shell Camden Bay EP EA (USDOI, BOEMRE, 2011a).

Barrow. In late autumn-early winter after the bowhead whale hunt, many Barrow residents direct their subsistence efforts inland to hunt caribou and moose, trap furbearers, and fish. By this time, the caribou have migrated away from the coast. In a typical year, many Barrow residents expend their greatest effort fishing for these species as well as Dolly Varden and burbot (SRB&A, 2010). Most fishing occurs at inland fish camps, particularly in lakes and rivers that flow into the southern end of Dease Inlet (USDOI, MMS, 2009; SRB&A, 2010: Maps 16-24).

In Barrow, some hunters continue seeking marine mammals and polar bear on the sea ice after the fall bowhead whale hunt has ended. Ringed seals are harvested throughout the year at Barrow. Formerly, hunts were conducted more frequently on the sea ice than at the present. Winter has been described as the best time to go hunting for pinnipeds, and hunters might travel 35 miles north of Point Barrow on the ice (SRB&A, 2010) (Figure 2). Between 10 and 15 ringed seals are harvested by Barrow hunters in November and December, and more than 5 are harvested in October after the whaling season ends (SRB&A, 2010). One hunter characterized the situation this way:

> *There's only a few of us that still hunt seals in Barrow in the winter. You have to real careful and smart and know what you're doing, and if you see someone out there who's not usually out there at those times, you have to look out for them. Look out for wind conditions. Make sure you're on the right side of the crack.* (SRB&A, 2010: 90)

Only a few bearded seals and walrus are hunted during the winter (SRB&A, 2010). Barrow residents hunt polar bears from October to June as far as 60 mi offshore (USDOI, BOEM, 2011).

Barrow's subsistence-harvest areas are depicted in detail in the MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 8-48).

3.2.7.2. Employment and Public Health.

Sociocultural systems encompass three concepts: (1) social organization, (2) cultural values, and (2) institutional organizations of communities. "Social organization" is defined as how people are divided into social groups and networks; "cultural values" are desirable values that are widely shared explicitly and implicitly by members of a social group; and "institutional organization" refers to the government or non-government entities that provide services to the community. These three concepts are interrelated. For most Alaska Natives, subsistence (and the relationship between people, land, water, and its resources) is the idiom of cultural identity, and production of subsistence foods is the activity around which social organization occurs. Institutional organizations, in turn, reflect and affect the social organization and cultural values. For the North Slope, Iñupiat traditions and practices largely define social organization and cultural values, while the civil and tribal governments and Native corporations largely define institutional organization. Although there have been substantial social, economic, and technological changes in Iñupiat lifestyle, subsistence continues to be the central organizing value of Iñupiat sociocultural systems and it is primarily through impacts to subsistence activities that impacts to sociocultural systems are assessed (USDOI, BOEMRE, 2011b).

3.2.7.3. Environmental Justice

The Environmental Justice (EJ) Executive Order 12898 requires each Federal Agency to make the consideration of EJ part of its mission. The Executive Order requires an evaluation in an EIS or EA as to whether a proposed activity would have “disproportionately high adverse human health or environmental effects…on minority populations and low income populations.” Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area potentially affected by Proposed Action activities. The ethnic composition of Kaktovik, Nuiqsut, and Barrow demonstrates that all three communities would be classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. The Statewide population is 15.4% American Indian and Alaska Native. On this basis, an evaluation of disproportionate impacts is required. Generally, disproportionate impacts on minority and low income populations are assessed based on the impacts to subsistence practices and consequent impacts on sociocultural systems (USDOI, BOEMRE, 2011b).

4.0 ENVIRONMENTAL CONSEQUENCES

The following subsections analyze potential direct, indirect, and cumulative effects on environmental resources as a result of Alternative 1 - No Action and Alterative 2 - Proposed Action.

Each alternative is analyzed for direct and indirect effects to the resources identified in Section 3.0. The analysis also identifies, where appropriate, mitigation that could be used to limit adverse effects. Potential cumulative effects are then discussed under each resource category. Each cumulative effects subsection discusses past, present, and reasonably foreseeable future actions that could affect each resource, and analyzes the potential for the Proposed Action to contribute incrementally to these impacts. The cumulative effects scenario (past, present, and reasonably foreseeable activities in the Proposed Action area) is presented in Appendix B. The cumulative effects analyses tier from the cumulative effects analyses in the previous, broader-scope NEPA documents cited in Section 1.3.

A level of effect determination (i.e., negligible, minor, moderate, or major) is provided by resource. Level of effect definitions are provided in Appendix A.

Fuel Spill Scenario. The petroleum spill scenario found in the 2010 ION G&G Seismic Survey EA (USDOI, BOEMRE, 2010a) is incorporated by reference and summarized as follows. BOEM estimates that 1-13 bbl could spill during a fuel transfer. A 1 bbl spill could persist for up to 30 hours in open water and up to 5 days in ice; a 13 bbl fuel oil spill could persist for up to 2 days in open water and up to 10 days in ice.

Invasive Species. An "invasive species" is defined as "a species whose introduction does or is likely to cause economic or environmental harm or harm to human health where it is introduced." (Executive Order 13112 of February 3, 1999: *Invasive Species*). Potential vectors for introducing aquatic invasive species are ballast-water discharge, fouled ship hulls, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays).

The USCG developed regulations (33 CFR 151) that implement provisions of the National Invasive Species Act of 1996 (NISA). Vessels brought into the State of Alaska or Federal waters are subject to these USCG regulations, which are intended to reduce the transfer of invasive species. The regulations require operators to remove "fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations" (33 CFR 151.2035(a)(6)). The regulations, however, do not specifically call for the same removal procedures for ocean-bottom cables or seismic equipment. There is a low potential for pelagic organisms and seaweed to become entrained in equipment towed during a seismic survey (Kinloch, Summerson, and Curran, 2003). Typical organisms that are returned with the seismic streamers are jellyfish tentacles and shark teeth. These items are removed from the streamer by hand before it is rewound on the drum. A systematic cleaning and scraping of equipment at the completion of a survey, as the equipment is brought onboard the vessel, is another way to minimize transfer of marine species and ensure that the equipment is stored properly prior to transit to a new location.

Large and widespread communities of invertebrates were found during surveys carried out between the Chukotka Peninsula and Point Lay in the Chukchi Sea (Sirenko and Gagaev, 2007). These were of temperate Pacific origin, warm-water invaders probably arriving by way of advection from southern waters. These communities included large invertebrate species such as bivalve molluscs (*Pododesmus machrochisma*) and crabs (*Telmessus cheiragonus* and *Oregonia gracilis*), species that were not previously recorded at this latitude. This published account confirms the potential of temperate species to become established in U.S. Arctic waters.

4.1. Alternative 1 – No Action

4.1.1. Direct and Indirect Effects

Under Alternative 1 –No Action, BOEM would disapprove the 2012 ION G&G Seismic Survey Application #12-01 and ION's proposed seismic survey would not occur. Not issuing the permit for the survey could result in delay in understanding of the geophysical makeup of the Beaufort Sea and Chukchi Sea and lost or delayed opportunities for discovery and extraction of natural resources and any associated economic benefits. It might also delay the acquisition of information on the extent of OCS oil and gas resources, and the ability to evaluate the evolution of the petroleum system at the basin level, including identifying source rocks, migration pathways, and play types.

Under Alternative 1 –No Action, there would be no disturbance attributable to the Proposed Action activities to any resources described in Section 3.0. There would then be no seismic survey effects on air or water quality, fisheries, lower trophic populations, EFH, marine and coastal birds, marine mammals, polar bear critical habitat, or accessibility of marine mammals for subsistence activities.

4.1.2. Cumulative Effects

The Arctic Ocean ecosystem is rapidly changing, with melting sea ice and increasing sediment input from numerous regional river systems. Open-water seasons are longer than in years past, allowing for increased sunlight and a reduction in multi-year ice. Activities currently ongoing in the U.S. Arctic region or which may occur in the foreseeable future and affect OCS resources include: increased marine vessel and air traffic, fuel and petroleum spills, permitted and non-permitted discharges, long-distance aerosol-transported pollutants, climate warming, sea ice melting, ocean acidification, and risk of invasive species from ship hulls and deployed equipment. Specific activities known to be scheduled to occur during 2012 are summarized and included in Appendix B, Cumulative Effects Scenario, of this EA.

The 2006 Seismic PEA and the Lease Sale 193 SEIS provide detailed descriptions of past activities, reasonably foreseeable future activities, and the environmental consequences of these activities in the Beaufort Sea and Chukchi Sea. If the Proposed Action does not take place, no additional effects would be added to the effects associated with ongoing or reasonably foreseeable future activities in the Beaufort Sea or Chukchi Sea.

4.2. Alternative 2 – Proposed Action

4.2.1. Air Quality

4.2.1.1. Direct and Indirect Effects

The operation of diesel marine engines on vessels proposed for the seismic survey would cause emissions of federally regulated air pollutants. Emissions would occur primarily from operation of the main and auxiliary engines aboard the *Geo Arctic* and the *Polar Prince*. *Geo Arctic* will be the seismic sound source and survey vessel; *Polar Prince* will perform as both icebreaker and the project's support and refueling vessel. An inventory of projected emissions from both vessels' engines was prepared to assess the potential for significant air quality impacts. The pollutants considered in this analysis include particulate matter (PM), nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), and carbon dioxide (CO_2).

The emission inventory was based on the operational characteristics of the *Geo Arctic's* and the *Polar Prince's* main and auxiliary engines. The *Geo Arctic* has up to 7,576 kilowatts (kW) of engine propulsion power, consuming 15 U.S. tons (t) of fuel per day. The *Polar Prince* would contribute up to 3,820 kW of additional engine propulsion power to the seismic operation, consuming 7 t of fuel per day. Total emissions likely to occur as a result of the 2012 ION Proposed Action in the Chukchi Sea and Beaufort Sea OCS for both vessels during one season are summarized in Table 6. The emission inventory accounts for the *Geo Arctic* traveling approximately 7,175 km (3,874 nm) over a period of 76 days. The *Polar Prince* is assumed to travel an additional 456 hours to account for travel to and from Tuktoyaktuck, Canada, for refueling, for a total of 2,280 hours. This analysis assumes that both ships would operate for 24 hours for each day of the survey. The inventory assumes that the survey has the Potential to Emit (PTE) pollutants as summarized in Table 6, based on emission factors listed in Table 7.

Table 6. Total Seismic Operations Emissions

Vessels	**Total Project Emissions – Potential to Emit (tons per season)**					
	PM	NO_X	SO_2	CO	VOC	CO_2
Geo Arctic	5.72	159.02	23.51	35.59	6.03	7,374
Polar Prince	2.81	96.28	16.22	22.07	2.87	4,654
Total Project	8.53	255.30	39.73	57.66	8.90	12,028

Source: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and 3.4-1.
EPA. July 2010. Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (EPA-420-R-10-016, NR-005d).

This PTE scenario would have all engines operating at full capacity 24-hours a day for every day of operations, which would be unlikely to occur as all sources would not actually operate 100% of the time. The significance of the potential air quality impact caused by the projected emissions in Table 6 was assessed by comparing the ION data to the analysis of a “typical” G&G survey with a seismic vessel having 8,000 kW of engine propulsion power, consuming 20,000-30,000 liters (L) (19-30 t) of fuel per day, as estimated for the 2006 Seismic PEA (USDOI, MMS, 2006).

Table 7. Emission Factors for Diesel Marine Engines

Engines Greater Than 600 hp (>447 kW)					
PM	0.43	g/kW-hr		0.001	lb/hp-hr
NO_X	14.60	g/kW-hr		0.024	lb/hp-hr
SO_2	2.46	g/kW-hr		0.004	lb/hp-hr
CO	3.35	g/kW-hr		0.006	lb/hp-hr
VOC	0.43	g/kW-hr		0.001	lb/hp-hr
CO_2	705.60	g/kW-hr		1.160	lb/hp-hr
Engines Less Than 600 hp (<447 kW)					
PM	1.34	g/kW-hr		0.002	lb/hp-hr
NO_X	18.86	g/kW-hr		0.031	lb/hp-hr
SO_2	1.97	g/kW-hr		0.003	lb/hp-hr
CO	4.06	g/kW-hr		0.007	lb/hp-hr
VOC	1.50	g/kW-hr		0.002	lb/hp-hr
CO_2	699.52	g/kW-hr		1.150	lb/hp-hr

Note: Assumes sulfur concentration of 0.0015 percent by weight.
Source: BOEM Form BOEM-0138-EP.
EPA, 1996. AP-42. Tables 3.3.1 & 3.4.1.

The emissions for a “typical” seismic survey operation analyzed in the 2006 Seismic PEA also included a support vessel that would contribute up to 6,000 kW of additional engine propulsion power. The 2006 Seismic PEA air quality assessment assumed an average seismic survey covering approximately 5,556 km (3,000 nm) over a period of 29 days. The analysis provided for the 2006 Seismic PEA estimated that a worst-case seismic operation scenario would have PTE emissions as summarized in Table 8.

Table 8. Potential to Emit (PTE) 2006 Seismic PEA Scenario

Vessels	Total Project Emissions – Potential to Emit (tons per season)					
	PM	NO_X	SO_2	CO	VOC	CO_2
Seismic Vessel	2.02	68.78	11.56	15.76	2.04	3,320.41
Support Vessel	2.25	75.63	12.64	17.32	2.28	3,643.30
Total Project	4.27	144.41	24.20	33.08	4.32	6,963.71

Source: 2006 Seismic PEA.

The air quality assessment prepared for the 2006 Seismic PEA determines that emissions from a typical G&G seismic survey would not result in pollutant concentrations that would exceed one-half (50%) of the maximum allowable increases under the EPA PSD regulations of 50 CFR 52.21. Further, the emissions would not have the potential to cause significant adverse air quality effects as defined in Appendix A of this EA. BOEM used the emissions estimated for the 2006 Seismic PEA as a threshold against which emissions from the 2012 ION Proposed Action could be compared.

The operating characteristics unique to the Proposed Action would decrease the likelihood of adverse impact to air quality because marine vessels are mobile sources, continually moving so that a constant long-term continuous stream of pollutants from a ship over a limited area would not occur. The emission concentrations below are projected based on engine emission rates, speed of the vessel, wind conditions, and the area over which the vessels are traveling (Arya, 1999).

The ships used for the Proposed Action would cover an area of 64,768 square miles applying varied power settings for cruising, slow cruising, and maneuvering. The concentration of emissions onshore decreases as the size of the affected area and distance from shore increases. Wind conditions on the open sea are also conducive to diluting emissions (Vallero, 2008). In addition, emissions from mobile sources are not controlled based on the location of the sources or the operating time. Rather, the engine emissions from each unit are controlled at the manufacturer under EPA guidelines for American-made marine engines, and also under the International Convention for the Prevention of Pollution from Ships (MARPOL) for foreign marine engines. As such, controls on the engine emissions from the ships are required to be built into their engine design. ION's seismic operations are expected to cause only short-term, local increases in offshore and onshore pollutant concentrations.

The PTE emissions projected for the 2012 ION Proposed Action of Table 6 cannot be compared directly to the PTE emissions calculated for the 2006 PEA survey in Table 8 because, while the same emission factors were used, the analysis for the Proposed Action reflects a higher number of operating hours, a longer cruising distance, and engines with power ratings slightly lower than assumed for the 2006 PEA survey. The operating parameters of each survey are compared in Table 9.

Table 9. Comparison of Operating Parameters

Operating Conditions	2006 Seismic PEA		2012 ION Proposed Action	
	Seismic Vessel	Support Vessel	Geo Arctic	Polar Prince
Operating Hours	690	863	1,824	2,280
Distance Traveled (nm)[1]	3,000	3,750	3,874	4,843
Engine Power Rating (kW)[2]	8,000	3,000	7,576	3,820

Notes: [1]nm = nautical miles. [2]kW = kilowatt power rating.
Source: 2006 Seismic PEA.

For a reasonably accurate comparison of emissions from the two surveys, emission rates from both were converted to determine total emissions of each pollutant in pounds of pollutant per hour of operation. The comparison of emission rates is summarized in Table 10.

Table 10 Comparison of Emission Rates: 2006 Seismic PEA and 2012 ION Proposed Action

Survey Scenario Source	Total Project Emission Rates (pounds per hour)					
	PM	NO_X	SO_2	CO	VOC	CO_2
2006 Seismic PEA	13.54	406.39	65.02	92.67	13.85	19,239.65
2012 ION Proposed Action	9.35	279.94	43.57	63.21	9.76	13,188.33
Difference	-4.19	-126.45	-21.45	-29.46	-4.09	-6,051.32

The data in Table 10 show that the emission rates projected for the 2012 ION Proposed Action would be lower than emission rates estimated for a typical seismic survey in the 2006 Seismic PEA. The emissions from the Proposed Action can be presumed to have a less adverse effect on air quality than the typical survey presented in the 2006 Seismic PEA. Consequently, the emissions generated from the operation of the two ships for the 2012 ION Proposed Action would not be expected to exceed one-half (50%) of the maximum allowable increases under the 50 CFR 52.21 and the emissions would not have the potential to cause significant air quality effects. Accordingly, BOEM estimates that the increase in pollutant concentrations resulting from the Proposed Action would be below the air quality significance threshold described in Appendix A and would be considered to have a negligible to minor air quality effect.

4.2.1.2. Cumulative Effects

The Proposed Action includes the temporary use of marine vessels which are pollutant sources that could contribute to the emission budget within the NSB. In addition, the Proposed Action may impact other activities occurring in the same region of the Beaufort Sea and Chukchi Sea that could have adverse cumulative effects on air quality. Specifically, any additional activities occurring during the same time period and in the same general area requiring the use of large marine vessels may cause emissions to build up in the atmosphere to levels harmful to human health or wildlife, particularly when combined with existing emissions in the area. However, the Proposed Action is scheduled to occur in ice conditions when most or all other maritime traffic will have ceased. When considering prevailing wind conditions over the open sea, the few emission sources onshore, and the distance of the proposed survey tracks from the shoreline, emissions from the Proposed Action, when combined with other operations in the Beaufort Sea and Chukchi Sea, would likely be diluted and dispersed resulting in pollutant concentrations far below the air quality standards at the shoreline. The incremental contribution of the Proposed Action to overall cumulative effects on air quality is expected to result in a minor level of effect and would not result in adverse impacts to air quality.

4.2.2. Water Quality

4.2.2.1. Direct and Indirect Effects

Icebreaker activity changes surface water salinities by mixing hypersaline water just below the ice (created by salt extrusion during ice formation) with deeper waters and ice. This would temporarily change the established surface salinity regime that existed prior to icebreaking.

Discharge from the seismic vessel, support vessel, and icebreaker would be regulated by EPA (EPA, 2011a) under the NPDES Vessel General Permit (VPG). The VPG contains effluent limits for different types of discharges including ballast water, deck runoff and washdown water, greywater, bilge water, cooling waters and brine waters. Discharges from the two vessels would include all of these effluent discharges. The potential effects on water quality are summarized in Section 3.2.2.

Seawater will be taken up by the icebreaker and the seismic vessel for freshwater production (total 35 m3 per day). Brine water discharge from the desalination process would have an elevated salinity above ambient average salinity and a temperature of ≤ 68°F (20°C) above ambient sea surface temperature. This discharge is expected to affect surface salinity and surface water temperature in the immediate vicinity of the discharge vessels before surface conditions return to ambient.

Table 11. Summary of Effects on Water Quality.

Activity/Waste Stream	Effects on Water Quality
Sanitary waste, gray water, bilge water, and ballast water discharge; deck drainage	Discharge of suspended solids, contaminants, pathogens, nutrients, detergents as permitted under NPDES Vessel General Permit
Desalination brine waters Cooling water	Increased salinity and warming in immediate surface and subsurface waters, minor constituents into surface waters as permitted under NPDES Vessel General Permit
Ballast water discharge, deployment of airgun arrays and streamer	Risk of introduction of invasive species

Fuel transfer from the *Polar Prince* to the *Geo Arctic* is expected once during the approximate 76 days of operations. A diesel fuel spill would introduce hydrocarbons to the surface water. Localized acute hydrocarbon toxicity levels in the surface water could occur initially; however, these acute concentrations would be short-lived due to volatilization of light hydrocarbons.

Mitigation. The following components of the Proposed Action are ways in which water quality effects would be mitigated:

- Operations conducted under NPDES Vessel General Permit administered by EPA.
- Fuel Transfer Plan.

The effect of the Proposed Action on water quality is expected to be minor and temporary in the immediate area of the seismic survey and icebreaker and negligible on the spatial scale of the Beaufort Sea and Chukchi Sea.

4.2.2.2. Cumulative Effects

Climate change continues to affect the Arctic environment. Effects include warming sea surface temperatures, reduction in sea ice extent and thickness, and increased acidity. The number of cargo, tourism, military, and research vessels in the region is increasing as the ice cover is reduced. This increases the risk of vessel accidents, groundings and potential oil and cargo spills and the potential introduction of marine invasive species. These ongoing effects would be included in the background effects on which the Proposed Action would occur.

The activities described in this analysis are projected for a near future time frame of October 17 – December 15, 2012. The incremental contribution of the proposed action to overall cumulative effects on water quality is expected to be minor and temporary in the immediate area of the icebreaker and seismic vessel and negligible on the spatial scale of the Beaufort Sea and Chukchi Sea.

4.2.3. Lower Trophic Levels.

4.2.3.1. Direct and Indirect Effects

Direct effects from activities associated with Proposed Action would be limited to the icebreaking activities, and energy emitted during 2D seismic survey, and, potentially, an accidental refined petroleum spill during refueling of the *Geo Arctic* by the *Polar Prince*. Indirect effects would include disturbance of lower trophic populations due to vessel operations.

Vessel operations and the noise associated with ship operations and icebreaking activities are not known to have adverse effects on benthic invertebrate populations. This is especially applicable considering the late season scheduling of the Proposed Action and the timing of most invertebrate reproductive cycles, which generally peak during the increased light availability period of the summer months.

Effects of icebreaking activities on lower benthic invertebrates and lower trophic level organisms may include a temporary increase in primary productivity. This increase would be a result of potentially higher levels of light available to the epontic ice environment, allowing for a temporary growth increase of ice algae. Ice breakup would also include release of organic carbon within a potentially narrow ecological zone near transects of the seismic vessel. These effects would be negligible to the described environments.

Available evidence suggests that seismic survey noise in the environment is not completely without consequences to invertebrate populations. Off the coast of Spain in 2001 and 2003, beaching of giant squid (*Architeuthis dux*) coincided with vessels conducting seismic surveys using air guns. Investigations found pathological damage to the statocyst organs (a sensory organ comparable to the mammalian cochlea) of the beached squid (André et al., 2011). In response to these occurrences, experimental work was conducted by André et al. (2011) using four cephalopod species. This study indicated changes in the statocyst organ as a result of low-energy, high-frequency sound. Experimentation was carried out using two squid species, one octopus species, and one cuttlefish species, which were exposed to sound energy simulated to approximate air-gun energy intensity levels similar to those used during G&G seismic studies (the study utilized sound intensities of 152 dB to 175 dB at frequencies of 50 Hz to 400 Hz). While the work above clearly demonstrates morphological and physiological effects on individuals under specific controlled circumstances, it does not indicate that the proposed action will have more than temporary effects on invertebrate populations in proximity to the air gun array. Effects on populations of invertebrates in the proposed action area will be negligible.

A fuel spill due to the refueling of the *Geo Arctic* could potentially result in a spill of 1-13 bbl. The effects of these potential spills would be localized to nearby planktonic organisms present during the time of refueling. Likely surface water conditions of at least minor wave action would lead to a rapid dispersal and dissipation of refined petroleum products. The effects of a potential spill of 1-13 bbl would be negligible.

4.2.3.1. Cumulative Effects

Cumulative effects include the effects of a potential small fuel spill during refueling operation, and the potential effects of energy emitted by air-gun arrays during survey operations. The cumulative effects also include those ongoing, planned, or reasonably foreseeable activities discussed in Section 3.0 and Appendix B, Cumulative Effects. The incremental contribution of the Proposed Action to overall cumulative effects on lower trophic populations is expected to result in a negligible level of effect.

4.2.4. Fish and Essential Fish Habitat

4.2.4.1. Direct and Indirect Effects

4.2.4.1.1. Fish

Noise from seismic airguns, ship noise (engines, propellers, ramming, cavitation, and bubblers) would affect fish. The two airgun sub-arrays would discharge about every 18 seconds. Pelagic species, such as adult Arctic cod, adult salmon, and similar species, would startle and scatter during ramp-up and, in theory, receive reduced levels of seismic energy. These behaviors could result in decreased feeding efficiency (Purser and Radford, 2011); scattering of fish away from food sources; interference with sensory orientation and navigation; and redistribution of fish schools and shoals (Fay, 2009).

Sedentary, burrowing, territorial, benthic-obligated fish; shallower near-shore fish; fish eggs; and fish larvae in the project area would be exposed to a higher level of seismic survey activity due to their limited swimming behaviors, obligate life history characteristics, behavioral traits, or spatial limitations. Seismic survey activity and noise may adversely affect foraging and reproductive behaviors of these benthic-obligate fish.

The airgun sub-arrays would pass through the pelagic environment at a depth of ~8.5 m. A receiver streamer (4.5-9 km) would pass through the pelagic environment at ~9.5 m depth. The sub-arrays and receiver streamer themselves would cause physical disturbance and displacement of fish at these depths; these effects would be in addition to noise from the airgun discharges.

The Proposed Action will entail ~7, 175 km of track line in the Beaufort Sea and northeastern Chukchi Sea where Arctic cod are abundant. Arctic cod use sea ice for shelter and as a forage habitat to feed on microorganisms. Based on the existing scientific information on Arctic cod in the U.S. Beaufort Sea and Chukchi Sea, Arctic cod would be nearshore in the project area feeding in late summer and early autumn. As the autumn ice thickens and eventually freezes to the bottom in shallow nearshore areas, Arctic cod would move farther offshore where they spawn under the ice between November and February.

The Proposed Action is planned for October 17, 2012 through December 15, 2012 in the following order in the project area: northeast Beaufort Sea, southeast Beaufort Sea, northwest Beaufort Sea, southwest Beaufort Sea, Chukchi Sea. The track lines would overlap with Arctic cod open-water and sea-ice habitat. The effects of icebreaking on Arctic cod between October and December could entail disturbance to foraging, migration and spawning activity. Arctic cod have been observed among broken ice floes in the wake of icebreakers or splashed on top of ice floes (Crawford, 2003; Gradinger and Bluhm, 2004; Horner, 1976) indicating that individual Arctic cod and other ice-associated fish could be injured or killed along the icebreaker track lines.

There is a potential for a fuel spill during fuel transfer between vessels. A fuel spill would introduce hydrocarbons to the surface water and would cause acute toxicity effects on fish in the surface layer in the immediate area of the spill.

There is a temporary, low probability risk of introducing invasive species through deployment of seismic equipment brought in from other seas. Invasive species, including microorganisms, could affect fish through disease and competition for food or habitat. Vessel discharges (bilge water, grey water, ballast water, brine water) would be regulated under NPDES vessel general permits. The regulated discharges could affect the water quality in the immediate area of surface dwelling fish.

It is expected that the proposed icebreaking and seismic survey activities would have direct and indirect, localized, negligible effect on fish, their habitat and prey in the immediate vicinity of the survey vessels. Across the project area and across the 3-month activity period, however, the combined effects of the activities would have a minor level of effect.

Mitigation. The spacing of seismic survey lines and the mitigation measures listed in Sections 2.3 and 2.4 would mitigate some of the effects of the Proposed Action on fish.

4.2.4.1.2. Essential Fish Habitat

BOEM is in consultation with NMFS under the Magnuson-Stevens Fishery Conservation and Management Act for the purpose of analyzing potential effects to designated EFH, including waters and substrate, for Arctic cod (adult and late juvenile), Pacific salmon (adult and late juvenile), and saffron cod (adult and late juvenile).

Icebreaker and seismic activities are proposed from October 17, 2012, through December 15, 2012. The geographic range of the Proposed Action area includes EFH in both the Beaufort Sea and Chukchi Sea. All of the proposed seismic track lines occur in designated adult and late juvenile Arctic cod and Pacific salmon EFH, and the extreme southwestern seismic track line proposed in the Chukchi Sea overlaps with a segment of designated juvenile and adult saffron cod EFH.

The following information was considered in analyzing the effects of the Proposed Action on EFH:

- Arctic cod has a wide range and is abundant in the range in which they occur.
- Arctic cod adults and juveniles are pelagic-swimmers or demersal-swimmers (commonly schooling) that are capable of avoiding some activities.
- Pacific salmon occur in low numbers in the Chukchi and Beaufort marine and estuarine areas in the Proposed Action area.
- The Proposed Action will not occur near designated Pacific salmon freshwater spawning and rearing EFH.
- The Proposed Action overlaps a small portion of the entire EFH designated for saffron cod in the U.S. Arctic.

Potential direct and indirect effects from the Proposed Action on adult and late juvenile Arctic cod, saffron cod, and Pacific salmon (marine life stages), their habitat and their prey include:

- Exposure to seismic survey sound pulses (including airguns) causing short-term disturbance and displacement, cessation of normal behaviors, startle responses, avoidance swim responses, and associated physiologic effects.
- Vessel and icebreaking noise causing disturbance or displacement of fish.
- Localized physical break-up to Arctic cod sea-ice habitat.
- Exposure to a vessel transfer fuel spill at sea, vessel discharges, and deck drainage causing changes in surface water quality, which may elicit startle responses, displacement and physiologic effects in EFH fish in the surface water.
- Exposure to invasive species through deployment of acoustic equipment.

The Proposed Action may cause temporary and localized adverse effects from noise disturbance and discharges along survey tracklines that overlap EFH. Such effects would be dispersed over the Proposed Action area during the proposed October – December time period of the operations. This particularly applies to juvenile Arctic cod, owing to their utilization of niches found within ice structure during foraging and use of ice for resting and protection from predation.

Based on this EFH analysis, BOEM has made the following determinations:

- Adult and juvenile Arctic cod EFH: temporary adverse effects.
- Adult and juvenile Saffron cod EFH: no adverse effects.
- Adult and juvenile Pacific salmon EFH: no adverse effects.

Mitigation. Proposed Action and BOEM-proposed mitigation measures are presented in Sections 2.3 and 2.4, respectively. Some of these measures, such as airgun ramp-up, would mitigate some of the effects of the Proposed Action on designated EFH. Adherence to the mitigation requirements designed into the CWA NPDES permits and USCG regulations would further mitigate any adverse effects of the Proposed Action through reduction of waste water discharged, and decrease in likelihood of introducing invasive species deleterious to fish.

4.2.4.2. Cumulative Effects

4.2.4.2.1. Fish

There are several factors that are currently influencing the Arctic environment such as the presence and / or transits of cargo barges, cruise ships, research vessels and ongoing oil and gas industrial activities (refer to Appendix B, Cumulative Effects, for details of planned 2012 activities). These activities could cause vessel fuel spills, petroleum spills, nonpoint runoff to the sea and icebreaking.

In light of the baseline of these existing activities, the proposed icebreaker seismic survey over the maximum duration of the Proposed Action would contribute a minor effect to the current overall cumulative effects on fish and their habitat. The effect of the Proposed Action, when combined with past, present and reasonably foreseeable future activities, would be minor for fish and EFH dispersed throughout the region. The incremental contribution of the Proposed Action to overall cumulative effects on fish within the Proposed Action area is expected to result in a minor level of effect.

4.2.4.2.2. Essential Fish Habitat

Several factors are influencing EFH in the Proposed Action area including the presence and/or transit of cargo barges, research vessels, coastal construction and runoff, vessel discharges including water, underwater noise, and ongoing oil and gas industrial activities (refer to Appendix B, Cumulative Effects Scenario, for details of planned 2012 activities). In addition to noise, physical presence, and routine permitted discharges, these activities could cause vessel fuel spills, petroleum spills and nonpoint runoff to the sea. Climate change is having an effect on the Arctic environment through warming sea surface, reduction in sea ice, increased ocean acidification, changes in extent and quality of sea-ice habitat, and changes in freshwater discharge and nearshore salinities (Hopcroft et al., 2006). Over time, these climate change factors could affect the range of EFH species, particularly Pacific salmon extending north and eastwards from the Bering Sea and Chukchi Sea, and also affect the characteristics of freshwater waterbodies in winter. These factors would be having effects during the Proposed Action.

The incremental contribution of the Proposed Action to overall cumulative effects on EFH is expected to result in a minor level of effect.

4.2.5. Marine and Coastal Birds

4.2.5.1. Direct and Indirect Effects

Potential negative effects of the Propose Action on coastal and marine birds are summarized in categories of:

- Disturbance from the physical presence of vessels.
- Disturbance from noise by vessels, icebreaking or seismic airguns.
- Collision with vessels.
- Mortality from fuel spills from vessels.

Vessels could disturb birds in their path. There is an energetic cost to repeatedly moving away from vessel disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Seismic survey activity is expected to have only temporary and localized disturbance effects on relatively small numbers of certain marine bird species that are distributed in low density over the Proposed Action area. Any displacement to these birds is expected to be temporary. No operations would take place in the Ledyard Bay Critical Habitat Unit, an area important to spectacled eiders.

During the course of normal feeding or escape behavior, some birds could conceivably be near enough to an airgun to be injured by a pulse. The reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. Injury to birds in offshore waters is expected to result in a negligible level of effect because birds are most likely to move away from slow-moving seismic vessels well in advance of the towed seismic-airgun array.

Many seabirds, attracted to lights and vessels in nearshore waters, could collide with structures and be injured or killed. No birds were reported to have collided with seismic survey vessels during open-water seismic surveys when mitigation measures to minimize escaped lighting were in effect. Birds have been observed to alight on vessels to rest, but were not there as a result of a collision. Given the survey time frame, in which the vast majority of birds have migrated out of the survey area, few, if any, birds would be in the Proposed Action area. Few, if any, birds would likely be injured through collisions with ION's vessels. Although not expected to occur, some mortality is remotely possible and even one bird mortality from a vessel collision would be considered a minor level of effect.

Should a fuel spill of the magnitude defined in the Section 4.0 fuel spill scenario occur during refueling, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns. Few birds are likely to be in the area during refueling. In the unlikely occurrence of a fuel spill, there is some potential for a limited amount of individual bird mortality (and all birds contacted by spilled fuel are assumed to die), which could result in a minor level of effect; however, it is most likely that spill prevention and response measures would minimize adverse effects to marine and coastal bird populations.

Overall, Proposed Action is expected to have a negligible level of effect on marine and coastal birds.

4.2.5.2. Cumulative Effects

Appendix B, Cumulative Effects Scenario, identifies other activities that could overlap in space and time with the Proposed Action. The direct and indirect effects of the Proposed Action would have a negligible level of effect because there are few activities that occur in space and time with the Proposed Action, which would be conducted during a time when there are few marine and coastal birds in the Proposed Action area. The incremental contribution of the Proposed Action to overall cumulative effects on marine and coastal birds is expected to result in a negligible level of effect.

4.2.6. Marine Mammals

4.2.6.1. Direct and Indirect Effects

Potential effects of the proposed seismic-survey activities on marine mammals are summarized in categories of:

- Disturbance from the physical presence of vessels.
- Disturbance from noise by vessels, icebreaking or seismic airguns.
- Collision with vessels.
- Direct and indirect results of fuel spills from vessels.

The marine mammal species likely to be present in the Proposed Action area during all or part of the proposed survey period (October 17 through December 15) are bowhead and beluga whales, ringed and bearded seals, and polar bear.

Generally, in open water most marine mammals move away from or avoid vessels, including those vessels engaged in conducting seismic survey operations (Richardson, et al., 1995a; Richardson et al., 1995b) In ice covered waters, marine mammals often occur in open leads, polynyas or at breathing holes (ringed seals). Marine mammal species may move away from icebreaking or take advantage of the open-water leads created by the icebreaker (Erbe and Farmer, 2000; Brueggeman et al., 1991, 1992; Richardson and Malme, 1993). For some species, taking advantage of the open lead created by the icebreaker may be more advantageous than moving away from the seismic and vessel noise (Brewer et al., 1993). Careful monitoring throughout the Proposed Action will be necessary to avoid impacting marine mammals and could provide important information on interactions between icebreakers and marine mammals during icebreaking operations. Because the noise frequencies produced by icebreaking and ships' engines are higher than those of seismic airguns, one should not mask the other, nor should they be additive. Engine noise from the survey vessels would be similar to those of icebreaking, making them additive. Impacts to marine mammals from noise are expected to be limited to temporary disturbance effects with no significant physiological repercussions as long as power down/ shut down procedures are followed and exclusion zones are adequately monitored by trained PSOs. If PSOs are not on duty to monitor the exclusion zones, then marine mammals may enter zones close enough to active seismic operations to sustain injuries, such as temporary threshold shifts in hearing.

The Proposed Action states that PSOs are required to be on duty during all daylight periods of airgun operation and that no PSO's will generally be on duty at night. The ability of PSOs to effectively monitor the exclusion zone is a critical component in ensuring that the Proposed Action will not have a major effect on marine mammals. Adequately monitoring for the presence of marine mammals and shutting down seismic survey operations if a marine mammal enters the exclusion zone requires trained observers dedicated to that purpose, and trained to use the specialized low-light equipment that ION has proposed for their use. The analyses below assume BOEM's requirement for nighttime PSOs is in place.

Operating any size of mitigation airgun is unlikely to have any measurable effect on polar bears since they typically swim with their heads out of the water, or they walk on sea ice. Of concern is the possibility that a polar bear in the water may become injured by rapidly shifting sea ice in the wake or proximity of an operating icebreaker or seismic survey vessel.

If a marine mammal enters the exclusion zone, the seismic airgun array is powered down or shut down (as per FWS and NMFS requirements). Shut downs very rarely occur, as most marine mammals avoid seismic operations vessels in open water, and PSOs are usually able to initiate a power down before a marine mammal enters the 180 / 190 dB shut down zone.

BOEM has not previously allowed start-up of the seismic airgun array during periods of darkness or poor visibility due to concerns about being able to adequately view the exclusion zone. While night vision binoculars (NVG) and FLIR equipment can be used to augment the visible range, they have limited proven usefulness in locating marine mammals at night and have a limited effective range. Moreover NVGs and FLIR have very limited functionality in detecting marine mammals in the water, particularly seals. Trained observers will have a better chance than the ship's crew to spot marine mammals even at night.

ION has stipulated that should a full shut down occur during periods of darkness or restricted visibility, a PSO would be required to confirm that the exclusion zone is clear of marine mammals for a minimum of 30 min prior to the ramp-up of the airgun array. This would require that the PSOs be capable of viewing a minimum of 215 m from the vessel in all directions. In water depths of <100 m, where marine mammals more commonly occur, the 180 dB exclusion zone could be as much as 2,850m (Table 1).

Few vessel-based seismic surveys have taken place outside of the open-water season. To address the potential for impacts from the icebreaking in combination with seismic sound surveys, BOEM reviewed and evaluated the information in the reports from previous seismic surveys using icebreakers. Although this is a relatively new methodology, some similar work has been done. Previous surveys were conducted from August through September and did not extend later in the fall.

These prior surveys resulted in a negligible or minor level of effect to marine mammal species, as defined in this EA (LGL, 2010; Mosher, Shimeld, and Hutchinson, 2009; Haley and Ireland, 2006; Haley, 2006; Haley et al., 2009).

Icebreaker activity in fall/winter, when temperatures are cold and the ice is forming quickly, has very little impact on the availability of ice as habitat. Icebreaker tracks refreeze very quickly, within a matter of several hours in many cases. Icebreaker effects are overshadowed by the natural variation in land fast ice, which involves constant re-breaking, which becomes more prevalent in pack ice. Impacts from icebreaker track lines in fall / winter would be very short term (Eicken and Mahoney pers. commun., 2010; Mahoney, 2010).

A collision between the seismic vessel or icebreaker and a marine mammal is possible but very unlikely for these operations. Few marine mammals will be in the area at the time of year of the Proposed Action other than polar bears and seals, which are highly maneuverable. Seismic vessels move slowly, at a speed of about 5 kts, and do not change direction quickly when operating seismic equipment. The combination of slow speeds and steady direction enables marine mammals to avoid the vessels with relative ease.

The *Geo Arctic* is expected to refuel once during the survey, probably during late October. PSOs will determine that the area is clear of marine mammals before refueling begins. Both vessels will have adequate supplies on board to respond to a small spill should one occur. A small spill could occur during re-fueling but is not likely to impact marine mammals.

The vessels would enter the U.S. Beaufort Sea from the southwest on or after October 17, 2012. When the survey is complete, or when ice or weather conditions end the survey, but not later than December 15, 2012, the *Geo Arctic* and the *Polar Prince* would depart the Chukchi Sea for Dutch Harbor. Impacts during the transit are expected to be limited to temporary disturbance and do not differ from the impacts of other ice-capable ship traffic.

Bowhead Whale. Available information indicates that bowhead whales, an endangered species, are responsive to anthropogenic noise in their environment. The bowhead's primary response to 2D seismic surveys would be avoidance of such operations, sometimes at considerable distance; however, responses are variable. Avoidance behavior could reduce the likelihood of bowhead whales incurring hearing injuries from airguns. Seismic surveys during the open-water period also have the potential to cause bowhead whales to avoid areas used for resting and feeding, and data indicate that fall migrating bowhead whales show greater avoidance of active seismic survey vessels than do feeding bowhead whales (Richardson, et al., 1995a; Richardson et al., 1995b). The potential cumulative adverse effects of noise, disturbance, and avoidance of feeding and resting habitat from all sources of disturbance in such an extremely long-lived species such as the bowhead whale are not completely understood. However, to date, monitoring of the population indicates that it is continuing to grow at a steady rate. Bowhead whale responses are likely to vary with time of year; sex and reproductive status of the whale; activity levels and their characteristics (e.g., airgun source levels, array configuration and placement in the water column); context (e.g., feeding versus migrating whales); the individual's motivation to be in an area; and the individual's options for alternative travel routes and places to feed. Available information does not indicate that there were detectable, long-term population-level adverse effects on the Bering-Chukchi-Beaufort Seas stock of the bowhead whale population from the high level of seismic surveys and exploration drilling during the late 1970's and 1980's in the Beaufort Sea and Chukchi Sea, or during seismic surveys conducted in 2006-2008. Sublethal impacts (such as reduced hearing or increased stress) could occur, but have not been documented.

The Proposed Action takes place after the bulk of the bowhead whale population has moved west of the survey area, specifically in order to reduce possible conflicts with subsistence hunting and also the fall bowhead whale migration through the Beaufort Sea. Few bowheads are likely to be encountered in the northeastern offshore area of the Beaufort Sea in early October. The survey is designed to move southward and westward after most of the bowhead whale population has migrated out of the area. The Proposed Action would likely greatly reduce the number of bowheads that might be encountered during the proposed survey when compared with an open-water summer survey. NMFS uses the 160 dB sound source level to assess Level B harassment impacts and the 180 dB sound source level to assess Level A harassment or potential injury levels to cetaceans. Sound source models provided by ION indicate that received sound levels of 160 dB could occur at distances of 27.8 km to 42.2 km depending upon water depth, and received sound levels of 180 dB could occur at distances of 0.58 km to 2.85 km depending upon water depth (Table 1). Estimates of take by harassment are based upon the 160 dB level. NMFS and FWS have determined that marine mammal harassment could occur when animals are exposed to sound levels at or above 160 dB. Individual bowhead whales, particularly those toward the end of the migration, could be exposed to seismic sound. The increased darkness during the proposed survey period substantially decreases the ability of shipboard personnel to identify bowhead whales within exclusion zones for power down or shut down purposes, but this may be offset because few whales are likely to be present. The refueling of the seismic vessel and icebreaker is likely to take place in late October or early November in the northwest Beaufort Sea when few bowheads are likely to be present near the seismic vessel. There will be sufficient daylight visibility at that time of year for the PSO on duty to determine if the area is clear of marine mammals before refueling takes place. Despite the limitations due to the increased darkness and inclement weather for the mitigation measures, the Proposed Action design still mitigates most impact on the bowhead whales. The Proposed Action would result in a negligible level of impact to bowhead whales.

Beluga Whale. The main fall migration corridor of beluga whales is ~100+ km north of the coast. Satellite-linked telemetry data show that some belugas of this population migrate west considerably farther offshore, as far north as 76ºN to 78ºN latitude (Richard, Martin, and Orr, 1997; 2001), which would be well beyond the range of the ION 2012 Proposed Action. Most beluga whales will have migrated out of the Proposed Action area prior to the onset of surveying. Beluga whales from the Beaufort Sea population could be encountered during the Proposed Action, but most whales will have migrated into the Chukchi Sea by the time the vessels reach the western Beaufort Sea. The proposed survey would begin after most belugas have migrated through the area. Research has shown that beluga may be displaced by seismic or icebreaker noise (Erbe and Farmer, 2000), which may result in some increased energetic costs. The possible single refueling of the seismic and icebreaking vessels is likely to take place in late October or early November in the northwest Beaufort Sea when few belugas are likely to be present near the seismic vessel. There will be sufficient daylight visibility at that time of year for the PSO on duty to determine if the area is clear of marine mammals before refueling takes place. Beluga that remain late in the season would be likely to avoid the noise of the seismic survey and icebreaking operations. The Proposed Action would result in a negligible level of effect to beluga whales.

Bearded Seal. Bearded seals have occasionally been reported to maintain breathing holes in sea ice; however, in winter they are found primarily in areas with persistent leads or cracks in broken areas within the pack ice, particularly if the water depth is <200 m. Bearded seals also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas 200 m deep or more. It is unlikely that large numbers of bearded seals would be encountered during the proposed survey because most would typically migrate south into the Chukchi Sea and Bering Sea in the fall with the advancing pack ice (Burns, 1970). It is possible that some bearded seals would be encountered during the Chukchi Sea portion of the survey and the transit south following operations. Impacts to bearded seals from the Proposed Action would primarily be disturbance or displacement. NMFS uses the 160dB sound source level to assess Level B harassment impacts and the 190 dB sound source level to assess Level A harassment or potential injury levels to ice seals. Sound source models provided by ION indicate that received sound levels of 160 dB could occur at distances of

27.8 km to 42.2 km depending upon water depth, and received sound levels of 190 dB could occur at distances of 180 m to 600 m depending upon water depth (Table 1). PSOs are unlikely to identify bearded seals at these distances, particularly during periods of poor visibility or darkness. Some individual bearded seals may be exposed to sound at the 190 dB level with minor short term impacts. Since most bearded seals will have migrated out of the area, impacts to bearded seals from the Proposed Action are anticipated to be negligible.

Ringed Seal. Ringed seals are likely to be the most commonly encountered marine mammal during the Proposed Action. During late fall and winter, ringed seals occupy shorefast ice and offshore pack ice of the Bering Sea, Chukchi Sea, and Beaufort Sea (Kelly et al., 2010; Allen and Angliss, 2010). In winter and spring, the highest densities of ringed seals are found on stable shorefast ice. However, in some areas where there is limited fast ice but wide expanses of pack ice, including the Chukchi Sea, total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Finley et al., 1983). Shorefast ice begins to form in October–November, and persists until May–July, depending on the location. At its maximum extent the shorefast ice extends seaward to about the 20 m isobath, which may be 40 km or more offshore (Stringer, Barrett, and Schreurs, 1980). Ringed seals make breathing holes in the newly formed ice and maintain the breathing holes as the ice thickens (Smith and Stirling, 1975; Smith and Hammill, 1981).

During late fall and winter, a seasonal shift in the ringed seal diet from hyperiid amphipods to Arctic cod occurs in the central Beaufort Sea (Lowry, Frost, and Burns, 1980; Bluhm and Gradinger, 2008). Arctic cod occur in nearshore areas and spawn during November – February (Craig et al., 1982), and this ephemeral prey resource may attract ringed seals. Impacts to Arctic cod in the Proposed Action area could lead to short term localized impacts on ringed seal prey availability.

The availability of sea ice habitat used by ringed seals varies on short (daily and weekly) as well as long (annual and decadal) time scales. Weather at the time of freeze-up and throughout the winter affects the ice roughness and snow cover, which in turn determine the suitability of ice as ringed seal habitat. Snow and ice conditions may change considerably within just a few days at any time of the season, particularly along the shorelines where fast ice occurs as an unprotected, linear band that abuts the pack ice and may be heavily impacted by storms and ocean currents. This variability makes between-year comparisons along the Alaska coast very difficult (Frost, Lowry, and Burns, 1988). The ringed seal status assessment concluded that impacts to ringed seals from decreases in sea ice and snow cover could be substantial (Kelly et al., 2010).

Savarese et al., (2009) reported that ringed seal was the most abundant seal species in the Beaufort Sea during vessel-based surveys in 2006–2008 with densities up to 0.068 and 0.096 seals/km^2 in the summer and fall, respectively. Haley et al. (2009) also reported that ringed seal was the most abundant seal species during similar vessel-based surveys in the Chukchi Sea during the same period with densities up to 0.054 and 0.171 seals/km^2 in summer and fall, respectively. Many unidentified seals during these surveys may have also been ringed seals and actual densities may have been higher.

Ringed seals may be disturbed by the icebreaker traffic and seismic vessel and forced to temporarily abandon the area. This disturbance is anticipated to result in some energetic cost and to have a temporary minor effect. Conversely, ringed seals may be drawn to the open water created by the icebreakers and may remain within the area in spite of the seismic activity. This could lead to an increase in hearing effects such as masking or TTS. Impacts to ringed seals are anticipated to be limited to disturbance, displacement or temporary effects on hearing and communication. The 190 dB received sound level varies from 180 m to 600 m depending upon water depth (Table 1). PSOs are unlikely to identify ringed seals at these distances, particularly during periods of poor visibility or darkness. Therefore, some ringed seals may be exposed to sound at the 190 dB level with minor short term impacts, but overall impacts to ringed seals from the Proposed Action are anticipated to be minor.

Polar Bear. For most of the year, polar bears appear to be relatively insensitive to noise or other human disturbances (Amstrup, 1993). Polar bears may be affected by noise and the presence of seismic survey sound and icebreaker activities or from changes to their sea ice habitat from icebreaking. Polar bears encountered while on the ice are unlikely to be affected by air guns, and swimming polar bears remain at the water's surface. Received sound levels near the surface are substantially reduced due to pressure release effects (Amstrup, 2003; Amstrup and DeMaster, 1988). Consequently, the most likely effects to polar bears from seismic surveys and associated activities would be the presence of vessels or activity, and potential changes to bears' food resources.

Reactions to vessel noise, and icebreaking sounds would be similar. Polar bears on ice may move into the water or depart an area to avoid areas where vessels are operating and may become stressed by energy expenditures related to vessel avoidance in the lead systems. Avoidance distances around icebreakers or other vessels may occur up to several kilometers or perhaps not at all. However, any effects would be very brief (Ireland et al., 2009; USDOI, FWS, 2009; Brueggeman et al., 1991). Females with cubs often react at greater distances, exhibiting more persistent responses and with greater intensity than single adults, resulting in increased energy expenditures. Brueggeman et al. (1992) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Although it is very difficult to assess aggregate cumulative population-level effects from short-term disturbance of individual animals, bears that already are nutritionally stressed may be impacted by chronic disturbances over time. In addition, polar bears are vulnerable to heat stress (Best, 1982; Stirling, 1988), and they may become overheated if forced to run to evade vessels in warm weather.

Any impacts of seismic activity to polar bear food resources will be minor, local and brief. Ringed seals are the primary prey of polar bears, and abundance and availability of these seals are not expected to be substantially altered by the proposed seismic surveys and associated activities. Polar bears may be drawn to icebreaker and seismic vessels by curiosity or may avoid them, depending on incident specific circumstances. Reactions may vary between individual bears, with females accompanied by cubs being most cautious. If ringed seals are drawn to the open leads created by the icebreaker, polar bears may be drawn to the area as well to exploit better hunting opportunities. The location of leads influences the distribution of foraging polar bears (Stirling, 1997), and they may take advantage of leads created by icebreakers, however leads created by icebreakers tend to refreeze quickly. Polar bears are known to take advantage of the leads forming downstream of drilling platforms, which are routinely used by seals (Stirling, 1988).

In the unlikely event that fuel was spilled during a fuel transfer and a polar bear was to encounter the spilled fuel in water or on ice, its coat could become fouled. Polar bears rely on their thick fat layer, subcutaneous tissues, and fur to avoid hypothermia, and a heavily oiled bear could become thermodynamically stressed when out of the water (Oritsland et al., 1981). Polar bears might also ingest toxins while grooming or oil from their fur or by foraging on seals that have become oiled (Amstrup, Durner, and McDonald, 2000; Amstrup et al., 1989; Durner and Amstrup, 2000). The current plan does not have the potential to spill any significant amounts of oil, however up to 13 bbl of diesel could be spilled during refueling if a refueling line was to rupture. Consequently if a polar bear were to become fouled by spilled diesel, the effects on that bear should be much less than would be expected from an oil spill due to the higher viscosity, faster weathering, and less inhibition to the thermal conductance of polar bear hairs by diesel fuel compared to crude oil. PSOs on board will verify that the 190 dB zone is clear of any marine mammals prior to the start of refueling. Given polar bears' dispersed distribution, and the fact that a small diesel spill could occur which may last no more than 2-10 days, very few polar bears could potentially be affected.

Female polar bears typically den in November throughout the Proposed Action area (USGS polar bear den data base, unpublished data), so winter icebreaking activity might affect polar bears denning in sea-ice habitats <300 m water depth (Amstrup, 2003); however, polar bears denning on sea ice usually select deep snow drifts adjacent to pressure ridges or jumbles of multi-year ice (Durner et al., 2004). The distribution of maternal dens appears to have changed in recent years; from 62% offshore dens (1985-1994) to 37% offshore dens (1998-2004) (Fischbach, 2007; Fischbach, Amstrup and Douglas 2007), perhaps were in response to delays in ice formation and reductions in pack ice suitable for denning. Amstrup and Garner (1994) noted only a small proportion (4%) of the southern Beaufort Sea polar bear population dens on the shore-fast ice adjacent to the Alaskan coast. The overall occurrence of dens on sea ice in the Arctic is thought to be relatively low based on recent radio-telemetry studies (Amstrup, 1995; Amstrup et al., 2006) and is decreasing as more polar bears den on land (Schliebe et al., 2008).

The seismic survey vessel cannot operate in pressure ridges and thick jumbles of multi-year sea ice, but it is possible icebreaker and survey vessel may transit through or near some multi-year ice or pressure ridges during the survey. Polar bears typically give birth in late December or early January, well after the survey would end, while bears disturbed from their dens early in the season, before giving birth, may readily relocate to a new den site as do other bear species (Amstrup, 1993). It is likely that bears are occasionally forced to locate new den sites early in the year due to storms that cause the ice to break up and re-form. Some bears may be disturbed from their dens by the icebreaker and seismic survey vessel; however these bears would be likely to move to another den site. Depending upon the speed with which the bear is able to locate another den site, and the amount of energy she expended in doing so, there could be impacts to reproductive success in some cases. Impacts to the polar bear are anticipated to be negligible to minor, and careful monitoring of the project will be necessary to determine the effectiveness of the mitigation taking place for a late-season activity occurring in sea ice rather than open-water conditions.

Polar Bear Critical Habitat. Polar bear critical habitat is made up of three units, terrestrial denning habitat, barrier islands and sea ice. The proposed seismic sound survey will be ≥13 mi from the barrier islands and shorelines, so no effects to terrestrial denning habitats or barrier islands are anticipated.

The proposed seismic sound survey overlaps only with Unit 1, sea ice. The Primary Constituent Element for Unit 1, sea ice, is “space for individual and population growth and for normal behavior” for polar bears using that habitat for feeding, breeding, denning, and movements (75 FR 76086, 2010).

Icebreaking has been shown to result in short term openings in the pack ice. During the fall and winter, the openings typically close quickly, most frequently within hours of icebreaker passage. If sea water temperatures fall below -1.8 degrees C (28.8 degrees F), new ice will form in the openings. Under certain wind, current, and water temperature situations, the openings could persist for longer periods. Icebreaking activities associated with the Proposed Action would take place in late fall when the sea ice is forming. The Proposed Action would affect relatively small areas of proposed critical habitat at any given time, as the ice will re-freeze behind the icebreaker and survey ship within a few hours to a few days (2010; Mahoney, 2010). No long-term or widespread effects on the areal extent and distribution of proposed critical habitats are anticipated because the ice is likely to be constantly shifting and moving during transit. Any adverse effects from icebreaking are expected to be brief and localized. No permanent or long-term adverse modification of critical habitat is anticipated.

4.2.6.2. Cumulative Effects

Cumulative impacts can result from individually minor but collectively significant actions taking place over time. The main agents of the cumulative activities scenario are past, present, and foreseeable: (1) climate change; (2) marine seismic surveys; (3) vessel traffic and movements (including icebreakers); (4) aircraft traffic; (5) oil and gas exploration in Federal and State waters; and (6) miscellaneous activities and factors. The miscellaneous activities and factors include subsistence activities, military activities, industrial development, and community development. Potential cumulative effects are summarized below.

BOEM has evaluated the potential effects of marine-streamer 3D and 2D seismic surveys, high resolution site-clearance seismic surveys, and ocean-bottom-cable seismic surveys in previous NEPA documents. Cumulative activities scenarios and cumulative impact analyses have focused on oil- and gas-related and non-oil and gas related noise-generating events/activities in both Federal and State of Alaska waters that were likely and foreseeable. Other appropriate factors, such as Arctic warming, military activities, and noise contributions from community and commercial activities, also were considered. Those previous analyses inform the analysis below.

Shipping noise, often at source levels of 150-190 dB, since 1950 has contributed to a worldwide 10- to 20-dB increase in the background noise in the sea. The types of vessels that produce noise in the Beaufort Sea and Chukchi Sea include barges with their associated tug boats, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with geological and geophysical exploration and oil and gas development and production. In the Beaufort Sea and Chukchi Sea, vessel traffic and associated noise presently is limited primarily to late spring, summer, and early autumn.

In shallow water, vessels more than 10 km away from a receiver generally contribute only to background noise (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Sound generated by shipping traffic commonly occurs at frequencies ranging from 20-300 Hz (Richardson et al., 1995a). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments contribute to overall ambient noise levels in some regions of the Beaufort Sea. The use of aluminum skiffs with outboard motors during fall subsistence whaling in the U.S. Beaufort Sea also contributes noise. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce stronger, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995a). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

ION proposes to begin operations after most local barge and boat traffic will have ended for the season. In general, impacts from planned seismic survey activities as well as from icebreaker operations are short term and localized. The footprint from ION’s icebreaking operations and vessel traffic would last a few min to a few hours in most cases, as the vessels passed through a given area, depending upon temperature and wind or storm conditions. The acoustic footprint of the seismic sound source of the full array at 180 dB would extend from 580 m to 2,850 m depending upon water depth (Table 1).

Overall, seismic surveys conducted during the open-water season may result in a negligible increase in cumulative effects to bowhead whales through the potential exclusion or avoidance by bowhead whales of feeding or resting areas and the disruption of important associated biological behaviors. Mitigation measures, including those imposed through the MMPA and ESA authorizations process, are designed to avoid Level A Harassment (injury), reduce the potential for population-level significant adverse effects on bowhead and beluga, and avoid an unmitigable adverse impact on their availability for subsistence purposes. The Proposed Action is expected to take place after most bowhead and beluga have migrated out of the area. The Proposed Action may disturb or deflect a few whales of either species, but would not add substantially to the cumulative impacts on bowhead or beluga from past, present, and reasonably foreseeable future activities.

Ongoing effects of climate change in the U.S. Beaufort Sea and Chukchi Sea include loss of habitat for resting and foraging for polar bears, walrus, and ice seals. Close monitoring and effective mitigation practices with respect to marine mammal populations and distributions are warranted, particularly with ringed seals and polar bears, which will likely be among the first marine mammals to show the negative effects of climatic warming (Amstrup et al., 2007; Kelly et al., 2010). The Proposed Action, with mitigation measures in place, may displace or disturb small numbers of polar bears on sea ice. Polar bears are currently threatened with extinction due primarily to changing climate affects and reduced sea ice. The negligible to minor impact of the Proposed Action does not change the overall level of effect to polar bears from past, present, and reasonably foreseeable future activities.

Icebreaker activities are increasing in the Proposed Action area as more research vessels and tourism cruises take place. Icebreaking activities temporarily alter ice habitat. In fall, this alteration may be fairly short term as new ice is quickly forming and storms are breaking and redistributing ice throughout the ice pack. The impact of each icebreaker cruise may be very small. Cumulative impacts depend upon the number of icebreakers operating in the Arctic, the spatial and temporal overlap in activities, and weather and natural ice formation in any given year. The incremental contribution of the Proposed Action to overall cumulative effects on polar bear critical habitat is expected to result in a negligible level of effect.

The incremental contribution of the Proposed Action to overall cumulative effects on marine mammals and polar bear critical habitat is expected to result in a negligible level of effect.

4.2.7. Subsistence Activities, Employment, Public Health and Environmental Justice

4.2.7.1. Direct and Indirect

4.2.7.1.1. Subsistence Activities and Employment

The areas of subsistence use by the communities of Kaktovik, Nuiqsut and Barrow are discussed in Section 3.2.8. An important consideration in assessing potential effects on subsistence activities is that ION’s activities would occur after fall bowhead whaling hunts have concluded in Kaktovik, Nuiqsut, and Barrow.

Based on the timing and spatial location of the Proposed Action, bowhead whale migration is expected to have passed to the west before ION begins survey activities in the eastern Beaufort Sea, and the survey would be expected to have no or negligible effect on the availability of bowhead whales for the Kaktovik, Nuiqsut, and Barrow subsistence whaling harvests. Transit of the vessels from the Chukchi Sea to the Beaufort Sea before the start of survey operations has the potential to affect Barrow’s subsistence hunt; therefore, BOEM proposes additional mitigation. If conflicts with subsistence resources and practices did arise, they would be expected to be associated with hunting for ringed seal, bearded seal, walrus, or polar bear undertaken from Barrow. Any such conflicts should be addressed and alleviated by prescribed IHA communication protocols and the proposed mitigation.

Seals are an important subsistence resource and ringed and bearded seals make up the bulk of the seal harvest of Kaktovik, Nuiqsut, and Barrow. It is assumed that effects on subsistence seal harvests in Kaktovik and Nuiqsut would be negligible given that the timing of the surveys would occur after fall sealing activities have concluded in these two communities. In Barrow, seals were traditionally harvested during the winter months, including October, November and December. This is a particularly challenging time of the year to hunt from the sea ice, as darkness increases and civil twilight decreases. The harvesting of bearded and ringed seals can occur on sea ice far offshore, and seismic survey activities could potentially conflict with the subsistence ringed seal hunt, the polar bear hunt, and to a lesser extent, bearded seal and walrus hunts. With appropriate and timely communication, negligible effects on Barrow's subsistence seal harvest would be expected (USDOI, BOEMRE, 2011b; SRB&A, 2010).

The spatial location and timing of seismic survey activities to avoid interference with the annual fall bowhead whale hunts in Kaktovik, Nuiqsut (at Cross Island), and Barrow; the use of protected species observers (PSOs) onboard survey vessels, as specified in the Plan of Cooperation (POC); and coordination and communication with local coastal subsistence communities are expected to keep impacts on subsistence resources and hunts in Kaktovik, Nuiqsut, and Barrow at a negligible level.

Based on the fact that (1) activities will avoid key bowhead whale subsistence harvest areas during critical harvest periods, and (2) ION will have a Communication Center in Deadhorse, manned by three operators, one from each potentially affected coastal community (Barrow, Kaktovik, and Nuiqsut) and will have a community liaison in each village to avoid subsistence hunting conflicts, it is anticipated that potential vessel disturbance from seismic survey and icebreaking vessels and the disturbance from seismic survey activities would have negligible impacts on subsistence resources.

4.2.7.1.2. Public Health and Environmental Justice

The health and welfare of the residents of the NSB is a primary concern. ION’s Proposed Action is entirely offshore, of limited duration, and would be performed according to all applicable statutes and regulations from a number of Federal, State, and local jurisdictions and agencies. More specifically, the terms of any IHA issued by NMFS and any Letter of Authorization (LOA) issued by FWS would typically mitigate industry conflicts with subsistence activities by specifying: (1) PSOs will be aboard all ION vessels to monitor for marine mammals and lessen exposure to project noise sources; and (2) PSOs will be in direct contact with local community Communication Centers which are in direct contact with ION to resolve potential conflicts with subsistence activities. The Communications Center will be located in Deadhorse at the NSB Services Area 10 location. There will also be Community Liaisons in Barrow, Nuiqsut, and Kaktovik to provide updates to local residents and to pass along questions to the vessels. In addition, provisions of any NMFS IHA (as authorized by the Marine Mammal Protection Act) require activities to have no unmitigable adverse effects on subsistence harvests. The provisions of ION’s plan of cooperation and the requirements of any MMPA authorizations should mitigate any adverse impacts on the health of NSB residents from disruption of subsistence activities. In terms of Environmental Justice, the Proposed Action would be expected to have no disproportionate adverse impacts on low-income or minority populations because of their expected negligible impact on subsistence resources, subsistence practices, and sociocultural systems.

The following analysis addresses the factors most likely to affect public health.

The *Geo Arctic* and *Polar Prince* will access the Beaufort Sea from Canadian waters, be self-contained in terms of fuel and personnel resupply for the duration of the project, and then depart the Chukchi Sea no later than December 15th and proceed directly to Dutch Harbor. Because no use of local infrastructure or local purchase of goods and service would occur, no adverse effects on public health are expected. Local hire would occur through the PSO program.

Based on the facts that the Proposed Action is expected to have negligible impacts on subsistence resources and no component of the Proposed Action occurs onshore, the Proposed Action is expected to have negligible to no impacts on sociocultural systems, environmental justice, and public health and safety.

Mitigation Measures. In addition to timing and locating of seismic survey operations to avoid bowhead whale harvest areas and harvest periods for Kaktovik, Nuiqsut, and Barrow, ION has incorporated mitigation measures from their 2010 IHA application request (ION, 2010a), as well as other measures, specifically designed to lessen or alleviate adverse impacts associated with its surveys on subsistence activities. In addition to marine mammal monitoring protocols and the local hire of protected species observers who will be placed onboard seismic vessels, additional subsistence mitigation measures would need to include measures required as part of ION's MMPA incidental take authorizations. The issuing of an incidental take authorization under the MMPA requires that the Services determine that "no unmitigable adverse effects to subsistence" will occur. It is expected that an approved IHA from NMFS would include a communication plan to ensure that ION coordinates its activities with local subsistence users in order to minimize further risk of impacting marine mammals and interfering with the subsistence hunt.

A Final POC has been developed by ION and distributed to potentially affected stakeholders, subsistence users, and community groups, as well as NMFS, FWS and BOEM. In addition, ION worked to develop a conflict avoidance agreement (CAA) with the AEWC and a communication plan with the Barrow Search & Rescue office, but details of the communication plan are unavailable at this time.

4.2.7.2. Cumulative Effects

Cumulative effects of associated activities in combination with other planned activities, as described in other Sections e.g. 4.2.6.2 above, would be considered negligible due to the lack of disruption of on-going traditional activities, the distance from shore, and the time of the year. The incremental contribution of the Proposed Action to overall cumulative effects on subsistence activities, employment, community health and environmental justice is expected to result in a negligible level of effect.

5.0 CONSULTATION AND COORDINATION

5.1. Endangered Species Act Consultation

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. The BOEM consults with FWS and NMFS for listed species under each Service's jurisdiction.

BOEM and NMFS, as Action Agencies, are in the process of jointly consulting with NMFS on the Proposed Action. Any necessary measures to minimize incidental take will be addressed through the IHA issued by NMFS.

BOEM completed formal programmatic consultation on May 8, 2012, on the spectacled eider, the Steller's eider, the Ledyard Bay Critical Habitat Unit, the polar bear, and polar bear critical habitat with the FWS. The May 8 programmatic consultation included in-ice seismic surveying.

5.2. Essential Fish Habitat Consultation

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended, federal agencies are required to consult with NMFS on any proposed action that may adversely affect designated EFH within or near the Proposed Action area. The consultation includes an assessment of EFH within the proposed action area and a description of measures to avoid, minimize, or otherwise offset potential adverse effects to the designated EFH.

Here, ION submitted a G&G permit application to the BOEM on March 9, 2012 to conduct a 2D seismic survey in the U. S. Beaufort Sea and Chukchi Sea (ION, 2012a). ION had submitted similar proposed actions in 2010 and 2011. Consultation was carried out and assessment document designations for effects on EFH and measures to offset potential adverse effects were accepted by NMFS for the 2010 ION G&G proposal. This decision was carried forward to the 2011 ION proposal. However, both the 2010 and 2011 proposals were cancelled due to problems with scheduling and mechanical issues on the part of ION, and a new consultation for the 2012 project proposal is moving forward. During the course of these three proposed action submissions, there have been changes in number of vessels (from the use of two icebreakers in 2010 to use of one in 2011 and 2012), areal coverage of seismic tracklines (a net reduction of 42 miles (70 km) from 2010 to 2012), and minor changes in seismic arrays utilized by the seismic vessel. These changes have necessitated a new EFH consultation with NMFS for the 2012 ION G&G proposal.

An EFH assessment for the 2012 ION G&G proposed action was submitted to NMFS on September 7, 2012. The assessment included descriptions of habitat as defined by the Arctic MFP for saffron cod and Arctic cod adult and late juvenile larval stages (NPFMC, 2009). Opilio crab EFH is described in the Arctic FMP, but the geographical boundaries of described EFH for that species is not within the Proposed Action area of the ION project and analysis for this species is not a part of the assessment. Also included are analyses of adult and late juvenile Pacific salmon EFH as defined and approved by the Salmon FMP (NPFMC, 1990). In summary, the assessment designated a finding of no adverse effects for saffron cod and Pacific salmon late juvenile and adult EFH. A designation of adverse effects was determined for Arctic cod juvenile and adult EFH, but at a local level and not at a population level. NMFS has verbally accepted BOEM determinations with respect to the potential for proposed actions to impact designated EFH.

5.3. Marine Mammal Protection Act

ION has committed to obtaining incidental take authorizations (ITA) from NMFS and FWS in the form of IHA and LOAs. ITA mitigation and monitoring requirements are generally intended to limit potential adverse impacts to marine mammals to a negligible level of effect and preclude unmitigable impacts to subsistence uses. The MMPA requires that authorized activities have no unmitigable adverse impact on subsistence uses of marine mammals.

ION's 2012 Proposed Action incorporates mitigation measures from their 2010 IHA application request (ION, 2010a), as well as other measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those measures are summarized in Section 2.3 of this EA.

ION applied for an Incidental Harassment Authorization (IHA) from NMFS (dated March 1, 2012) and a Letter of Authorization (LOA) from FWS (dated March 1, 2012) as a component of the 2012 ION G&G survey plan. Permit approval for the Proposed Action would be conditioned on ION's receipt of both thte IHA and LOA.

5.4. Archaeological Resources

The Proposed Action does not include any bottom-disturbing activities or any other activities with the potential to affect historic resources as defined under the National Historic Preservation Act (NHPA). BOEM approval of the Proposed Action would therefore not require consultation under Section 106 of the NHPA.

5.5. Public Involvement

Public participation regarding ION's proposed 2012 activities has been provided for through a combination of public notification of BOEM's receipt of the application and a public notice of EA preparation. On Wednesday, April 4, 2012, BOEM posted a request for public input on preparation of this Environmental Assessment for a 2012 Geological and Geophysical (G&G) Permit to Conduct Seismic Survey Activity in the Beaufort Sea and Chukchi Sea Outer Continental Shelf to the BOEM Alaska website. Comments were accepted through midnight April 30, 2012. BOEM received one comment on from a private citizen. This comment is available to view at: http://www.regulations.gov/#!documentDetail;D=BOEM-2012-0026-0002.

The public input is augmented by presentations at the NMFS Open Water and Scientific Review Committee (Peer Review) meetings in Anchorage, applicant's meetings with potentially affected stakeholders, and the NMFS Incidental Harassment Authorization (IHA) process.

In addition, opportunities for public input on seismic surveying in the Arctic OCS and related issues have been provided during several prior NEPA processes. These opportunities for public input are briefly summarized in the 2010 ION Seismic Survey EA (USDOI, BOEMRE, 2010a).

5.6. Reviewers and Preparers

The persons responsible for the review of ION's permit application and supporting information and analysis, and preparation of this EA are listed below:

Name	Title
Sue Banet	Supervisory Geologist
Chris Campbell	Sociocultural Specialist
Mary Cody	Wildlife Biologist
Deborah Cranswick	Supervisory Environmental Protection Specialist
Christopher Crews	Wildlife Biologist
Dan Holiday	Biological Oceanographer
Jana Lage	Geophysicist

Name	Title
Virginia Raps	Air Quality Specialist/Meteorologist
Mark Schroeder	Wildlife Biologist
Pete Sloan	Geologist
Caryn Smith	Oceanographer / Oil Spill Analysis
Bill Swears	NEPA Coordinator / Technical Editor

GLOSSARY

Airgun: An airgun is a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.

Cryosphere: the places on surface of the Earth where water is in its solid form, where low temperatures freeze water and turn it into ice.

Exclusion Zone: Also synonymously referred to as a safety zone within the ION source material, the exclusion zone is an area around the seismic-survey-sound source within a designated sound-level isopleth wherein marine mammals may be exposed to sounds that are considered a Level A take by NMFS. The exclusion zones are based on sound levels of 180 dB (for cetaceans and walrus) and 190 dB (for ice seals and polar bears). The exclusion zones must be clear of marine mammals prior to survey commencement, and must remain free of marine mammals during survey operations.

Harrassment: The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]."

Isopleth: A line on a map connecting points at which a given variable has a specified constant value. For seismic surveying, isopleths connect points of equal sound level (e.g. 160 dB, 180 dB, 190 dB).

Power-down Procedure: Reduction of the sound output of the airgun array to a level that would avoid exposing any marine mammal to the 180 or 190 dB (depending upon the species) exclusion zone.

Protected Species Observer (PSO): Formerly Marine Mammal Observer (MMO). PSOs are trained observers whose responsibilities are to observe, record, and inform the vessel crew of any sighted protected species. PSOs sold vessel duties 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 and/or FWS.

Ramp-up Procedure: Ramp-up of an airgun array consists of a gradual increase in sound level and a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The intent of ramp-up is to "warn" marine mammals in the vicinity of the airguns and to allow sufficient time for those animals to leave the area and avoid any potential injury or impairment of their hearing. Under normal conditions, animals sensitive to these activities are expected to move out of the area. Seismic surveys, including airgun testing or tuning, use the ramp-up procedures described below to allow whales and other marine mammals to depart the exclusion zone before seismic surveying begins.

Ramp-up procedures during seismic survey operations are as follows.

- Visually monitor the entire full array exclusion zone and adjacent waters for the absence of marine mammals for at least 30 min before initiating ramp-up procedures. If no marine mammals are detected, (15 min for ice seals and polar bears or 30 min for baleen whales and Pacific walrus), ramp-up procedures may be initiated.
- Initiate ramp-up by firing a single airgun, preferably the smallest in terms of energy output (dB) and volume.
- Continue ramp-up by gradually activating additional airguns over a period of at least 20 min, but no longer than 40 min, until the desired operating level of the airgun array is obtained.

Safety Zone: see Exclusion Zone.

Shut-down Procedure: Airgun operations may not be conducted when marine mammals are present within the exclusion zone. If a marine mammal is seen swimming toward the exclusion zone, the airguns may first be powered down to avoid exposing the marine mammal to the 180/190 dB level, depending on species. If the animal reaches the single airgun exclusion zone, the array must be shut down. Likewise, if a marine mammal surfaces within single airgun exclusion zone, the seismic survey must be shut down. If the airgun array is shut-down for any reason during darkness or poor weather, it may not be re-energized until conditions allow for the exclusion zone to be effectively monitored.

Start-up Procedure: Start-up is the initiation of airgun activity preparatory to ramp-up (either initial operation in the survey area, or subsequent to a shut-down). Start-up of airgun operations may not commence unless the 180 dB exclusion zone has been visible for at least 30 min prior to start-up, and no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus). If the array is shut-down pursuant to observation of a marine mammal, airgun operations may resume after the mammal has been observed to clear the exclusion zone for single airgun actuation or no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus).

Take/Taking: The term "take" under the MMPA means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." Under the MMPA, the 'taking' of marine mammals, incidental or otherwise, without a permit or exemption is prohibited, with a few exceptions. One such exception (as stated in Sections 101(a)(5)(A) and (D)) is for the incidental, but not intentional, "taking," by U.S. citizens, while engaging in an activity (other than commercial fishing) of small numbers of marine mammals of a species or population stock provided that the taking will have a negligible impact on such species or stock, will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses, and the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting are set forth. Additionally, pursuant to Section 101(a)(5)(D) of the MMPA monitoring plans are required to be independently peer reviewed where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

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APPENDIX A

LEVEL OF EFFECTS DEFINITIONS AND ABBREVIATIONS

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Appendix A - Table of Contents

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1. Introduction

This appendix defines and explains the levels of effect used in the EA to evaluate potential environmental impacts. Impacts are described in terms of frequency, duration, general scope, and/or size and intensity. Each level considers such factors as the nature of the impact, the spatial extent, recovery times, and the effects of mitigation. The terms negligible, minor, moderate, and major are used to describe the relative degree or anticipated level of effect of an action on a specific resource. Following each term listed below for a specified resource are the general characteristics used to determine the anticipated level of effect. For each term, best professional judgment was used to evaluate the best available data concerning the affected resource.

For each resource, a “significance threshold” is also provided. Adverse impacts that do not meet the significance threshold are considered “not significant.” Required mitigation measures may reduce otherwise “significant” impacts to a level of “not significant.”

The absence of a significant effect does not equate to “no effect.” As shown in the four-category scale, and in the numerous analyses that BOEM has undertaken, effects from activities can be adverse and noticeable before they reach the significance threshold. Furthermore, in the cumulative effects analysis, BOEM analyzes the combined effects of projected activities with other actions, because BOEM recognizes that effects that individually do not reach this significance threshold may exceed that significance threshold when considered collectively.

2. Levels of Effect

2.1 Air Quality

The levels of effect applied to the air quality analysis are based on the results of two levels of analyses, the emission inventory, and if required, the more rigorous ambient air analysis based on computer dispersion modeling.

2.1.1 Significance Threshold

A significant effect on air quality is determined when

1. Project-related emissions cause an increase in pollutant concentrations over the nearest onshore area of at least 20 square kilometers that
    a. exceeds half of any of the National Ambient Air Quality Standards (NAAQS) (except for ozone); or
    b. exceeds half of the maximum allowable increase for any pollutant for the Prevention of Significant Deterioration (PSD) for a Class II area under 40 CFR 52.21(c) or 18 AAC 50.020(b); or
    c. is expected to exceed half the ozone NAAQS based on an analysis of the potential increase in the ozone precursor emissions of volatile organic compounds (VOC) and nitrogen oxides (NOX); or
2. Design concentrations violate the NAAQS or if applicable, the Alaska Ambient Air Quality Standards (AAQS).

2.1.2 Level of Effects

Negligible

- Emission rates would be less than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Minor

- Emission rates would be equal to or greater than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Moderate

- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the PSD maximum allowable increases; or
- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the NAAQS, and, if applicable, the Alaska AAQS; or
- Increases in emissions of NOx and VOC would result in the formation of ozone to a level that would be expected to exceed one-half the ozone NAAQS.

Major

- Design concentrations of at least one pollutant would equal or exceed one-half the NAAQS, and, if applicable, one-half the Alaska AAQS; or
- Increases in emissions of NOx and VOC would result in the formation of ozone to a level that would be expected to equal or exceed the ozone NAAQS.

2.2 Water Quality

The levels of effect applied to water quality analysis consider the context and intensity of impacts, EPA's NPDES permitting program, and criteria under 40 CFR 125.122:

1. The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged;
2. The potential transport of such pollutants by biological, physical or chemical processes;
3. The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain;
4. The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism.
5. The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs;
6. The potential impacts on human health through direct and indirect pathways;
7. Existing or potential recreational and commercial fishing, including finfishing and shellfishing;
8. Any applicable requirements of an approved Coastal Zone Management plan;
9. Such other factors relating to the effects of the discharge as may be appropriate;
10. Marine water quality criteria developed pursuant to section 304(a)(1).

2.2.1 Significance Threshold

Significant effect on water quality is determined by any of the following: (1) the action is likely to violate its National Pollution Discharge Elimination System permit; (2) in the event of an accidental spill of crude oil or refined oil, total aromatic hydrocarbon or total aqueous hydrocarbon criteria for the Alaska marine or fresh-water quality standards are exceeded; or (3) the action is otherwise likely to introduce changes in the physical, chemical, or biological characteristics of a waterbody which case an unreasonable degradation of the marine environment as defined at 40 CFR 125.121 and determined in accordance with 40 CFR 125.122.

2.2.2 Level of Effects

Negligible:

- Temporary and localized impacts to water quality that do not cause an unreasonable degradation under 40 CFR 125.122.

Minor:

- Long-term and/or widespread impacts to water quality that do not cause an “unreasonable degradation” under 40 CFR 125.122.

Moderate:

- Impacts to water quality that exceed NPDES permit criteria or cause a temporary or localized “unreasonable degradation” under 40 CFR 125.122.

Major:

- Impacts to water quality that cause long-term and widespread “unreasonable degradation” under 40 CFR 125.122.

2.3 Lower Trophic Organisms

2.3.1 Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.3.2 Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No population level impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than one year and up to a decade.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.

- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Disturbances occur that result in measurable population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.4 Fish

2.4.1 Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.4.2 Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No mortality or impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable. Temporary, nonlethal adverse effects to some individuals.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Low mortality levels may occur, measurable in terms of individuals or <1% of the local post-breeding fish populations.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Mortalities or disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Some mortality could occur but remains limited to a number of individuals insufficient to produce population-level effects.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Mortalities or disturbances occur that have measureable and thus significant population-level effects.
- The action may adversely affect an endangered or threatened species or its habitat in a way that has been deemed to be critical under the Endangered Species Act of 1973.
- For fishes, the anticipated mortality is estimated or measured in terms of tens of thousands of individuals or >20% of a local breeding population and/or >5% of a regional population, which may produce short-term, localized, population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.5 Marine and Coastal Birds

2.5.1 Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine and Coastal Birds: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.5.2 Level of Effects

Negligible

- Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year.
- No mortality is anticipated.
- Mitigation measures implemented fully and effectively or are not necessary.

Minor

- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year, or localized effects that are anticipated to persist for more than 1 year.
- Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population.
- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate

- Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than one year, but less than a decade.
- Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect.

- Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major

- Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer.
- Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect.
- Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.6 Marine Mammals

2.6.1 Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine Mammals: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.6.2 Level of Effects

Negligible:

- No measurable impacts and no population-level effects.
- May cause brief behavioral reactions such as temporary avoidances of or deflections around an area.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No mortality or impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Low but measurable impacts with no population-level effects. Temporary, nonlethal adverse effects to some individuals.
- Localized, disturbance or habitat effects experienced during one season may accumulate across subsequent seasons, but not over one year.
- Mortality is not anticipated.
- May cause behavioral reactions such as avoidances of or deflections around an area.
- Mitigation measures are fully implemented or are not necessary.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Mortalities or disturbances could occur, but not on a scale resulting in population-level effects.

- Adverse impacts to ESA-listed species could occur. Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Some mortality could occur but remains limited to a number of individuals insufficient to produce population-level effects.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Mortalities or disturbances occur that have population-level effects. Mortality might occur at or above the estimated Potential Biological Removal (PBR).
- The action may adversely affect an endangered or threatened species or its habitat in a way that has been deemed to be critical under the Endangered Species Act of 1973.
- Widespread seasonal or chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.7 Sociocultural Systems

Sociocultural systems include social organization, cultural values, and institutional arrangements. The level of significance effect would be reached at the high level. The level of effects used for sociocultural systems is as follows:

2.7.1 Significance Threshold

A disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.7.2 Level of Effects

Negligible:

- Periodic disruption of social organization, cultural values, and/or institutional arrangements occurs without displacement of existing social patterns.

Minor:

- Disruption of social organization, cultural values, and/or institutional arrangement occurs for a period of less than one year, without a tendency toward displacement of existing social patterns.

Moderate:

- Chronic disruption of social organization, cultural values, and/or institutional arrangements occurs for a period of more than one year, without a tendency toward displacement of existing social patterns.

Major:

- Disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.8 Subsistence

2.8.1 Significance Threshold

Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

2.8.2 Level of Effects

Negligible: Subsistence resources could be periodically affected with no apparent effect on subsistence harvests.

Minor: Adverse impacts to subsistence activities are of an accidental and/or incidental nature and limited to a short-term.

Moderate: Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Major: Adverse impacts resulting in one or more important subsistence resources becoming unavailable, undesirable for use, or available only in greatly reduced numbers for any community.

2.9 Economy

The effects levels used for this analysis focus on the impacts associated with the Proposed Action on socioeconomic systems, including employment, personal income, and revenues accruing to the local, state, and federal government.

2.9.1 Significance Threshold

Economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.

2.9.2 Level of Effects

Negligible

- No measurable effects beyond short term, periodic impacts.

Minor

- Adverse impacts to the affected activity or community are unavoidable without proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected activity or community. Economic systems would be impacted for a period of up to 1 year.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action without any mitigation.

Moderate

- Impacts to the affected activity or community are unavoidable. Proper mitigation would reduce impacts substantially during the life of the project.
- Effects on economic systems would be unavoidable for a period longer than 1 year.
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project.

- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

Major

- Impacts to affected community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the project.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normal.
- Once the effect producing agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

2.10 Public Health

2.10.1 Level of Effects

Negligible

- Infrequent minor acute health problems, not requiring medical attention.
- No measurable effects on normal or routine community functions.
- No long-term consequences for Public Health or well being.

Minor

- Public Health affected, but the effects would not disrupt normal or routine community functions for more than one week.
- Effects would not occur frequently.
- Effects would not affect large numbers of individuals.
- Effects could be avoided with proper mitigation.

Moderate

- Adverse effects on Public Health occurring for brief periods of time that do not result in or incrementally contribute to deaths or long-term disabilities.
- Effects can be prevented, minimized, or reversed with proper mitigation.
- Effects could occur more frequently than minor events, but would not be frequent.

Major

- Effects on Public Health would be unavoidable and would contribute to the development of disabilities, chronic health problems, or deaths.
- Alternatively, occurrence of minor health problems with epidemic frequency.
- Effective mitigation might minimize the adverse health outcomes but would not be expected to reverse or eliminate the problem.

2.11 Environmental Justice

Executive Order 12898 requires Federal Agencies to evaluate whether proposed projects would have “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations.”

2.11.1 Significance Threshold

The significance threshold for Environmental Justice is when minority or low-income populations experience disproportionate, high adverse human health or environmental effects from the proposed action. Disproportionately high adverse impacts are those impacts which exceed the significance thresholds for subsistence, sociocultural, or public health effects for minority populations or low income populations.

2.11.2 Level of Effects

The levels of effect for Environmental Justice correspond to the levels of effects for subsistence, sociocultural, or public health effects as experienced by minority populations or low income populations.

2.12 Archaeology

2.12.1 Level of Effects

Negligible

- This category equates to No Historic Properties Affected as defined by 36 CFR 800.4(d)(1), the Code of Federal Regulations that promulgates Section 106 of the National Historic Preservation Act of 1966 as amended.

Minor

- This category equates to a finding of No Historic Properties Affected when the Agency identifies a potential conflict within an Area of Potential Effect due to the presence of a geomorphological feature and revises the plan to avoid it prior to consultation with the State Historic Preservation Officer.

Moderate

- This category equates to a finding of No Adverse Effect as defined by 36 CFR 800.5(b) when the SHPO identifies a conflict that requires a change in plan to avoid effects on an Historic Property as defined by 36 CFR 800.16(l)(1&2).

Major

- This category equates to a finding of Adverse Effect as defined by 36 CFR 800.5(C) requiring mitigation and a Memorandum of Agreement.

APPENDIX B

CUMULATIVE EFFECTS SCENARIO

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APPENDIX B. CUMULATIVE EFFECTS SCENARIO

B-1. CUMULATIVE EFFECTS DEFINED

The Council on Environmental Quality (CEQ) Regulations defines cumulative effects at 40 CFR 1508.7:

Sec. 1508.7 Cumulative impact.

> "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

B-2. CUMULATIVE EFFECTS SCENARIO

The scope of this assessment includes the incremental impact from the action alternatives plus the aggregate effects of other activities that are known to occur or that can be reasonably expected to occur at the same time as, and in the vicinity of the proposed action, and which have a potential to affect the same resources as the proposed action.

B-3. IMPACT SOURCES

The main sources of impacts which could have a cumulative impact with the proposed action on the resources in the Arctic OCS are: (1) marine vessel traffic, (2) aircraft traffic, (3) subsistence and other community activities, (4) scientific research activities, and (5) oil and gas-related activities.

3.1. Marine Vessel Traffic

Past marine vessel traffic has been associated with subsistence hunting, oil exploration, research, and military activities. Weather and ice have traditionally limited marine vessel traffic in the proposed exploration area to July through September.

The number of marine vessels in both the Beaufort and Chukchi Seas has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities of marine vessels, changes in ice cover and classification of ice, and increased interest in scientific and economic pursuits in the area. Reasonably foreseeable traffic in the region includes small craft involved in the fall whaling hunt at Barrow and Wainwright; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. The USCG estimates that from 2008 to 2010 the number of vessels in the Arctic increased from around 100 to more than 130, and the number of transits through the Bering Strait increased from around 245 to more than 325 (USCG, 2011). The estimated number of miles of non-seismic vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011).

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Chukchi Sea. Sound levels and frequency characteristics of vessel sound generally are related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel mechanical components that generate sound waves are propulsion engines, generators, bearings, pumps, and other similar components. Operations and navigation equipment, including fathometers and sonar equipment, are also inclusive of onboard mechanical components that cumulatively create and propagate sound into the marine environment through the vessel hull. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the action of spinning propellers. Moored vessels can generate sound from the operation of engines and pumps. Cranes or other similar operational equipment performing construction activities or other work functions may transmit sound directly to the marine environment through the air-water interface or indirectly through propagation of sound waves through hulls or other support structures.

3.2. Aircraft Traffic

Air traffic has increased in recent years, mostly from increases in academic and commercial ventures, and increases in military operations. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. An average of 306 commercial flights per month occurred from Wainwright airport between July and October, 2000 to 2008 (Bureau of Transportation Statistics, 2009).

3.3. Subsistence Activities and Other Community Activities

Subsistence hunting and other community activities associated with regional native villages such as Wainwright and Point Lay have persisted for millennia, and are expected to continue during the period of Proposed Action. Marine traffic associated with subsistence hunting consists of small craft used during fishing, seal hunting, and whale hunts. Vessel traffic associated with other community activities consists primarily of supply barges traveling close to shore, within state waters. Overall, vessel traffic associated with native village activities within the Proposed Action area is expected to be very low.

3.4. Scientific Research Activities

A considerable scientific research effort by governmental, non-governmental, and academic organizations operating from marine vessels and aircraft occurs annually in the Beaufort Sea and Chukchi Sea. The programs conducted by these organizations are generally expected to have ended for the season, or end for the season during October, but may produce cumulative impacts on resources analyzed for the Proposed Action. Marine environmental baseline studies involve deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for fish sampling and collection of phytoplankton, zooplankton, benthic invertebrates, and pelagic invertebrates. Also continuing will be observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring. Metocean buoys and acoustic wave and current meters will continue to be deployed for studies of physical oceanography and climate. Previous environmental assessments, such as the environmental assessment for Shell’s Beaufort Sea marine research program, describe the techniques used and the effects of these programs in detail (USDOI, BOEMRE, 2011).

Chevron Canada Resources Canadian Beaufort Seismic Program. Chevron Canada Limited has submitted a Program Description to the Canadian National Energy Board to conduct a ship-borne marine geophysical program consisting of 3-D and/or contingent 2-D swath seismic surveys in the Canadian Beaufort Sea. The proposed program would be scheduled for an estimated period of 40 to 70 days (weather dependent) between late July and mid-October 2012. The proposed seismic surveys would take place in the Canadian Beaufort Sea, approximately 120 km north of Herschel Island. The proposed project area consists of approximately 43,000 km^2, with water depths ranging from approximately 20 to 2,000 meters. The seismic source vessel would tow a dual sound source (airgun array) and up to 12 6-km long streamers of receiving hydrophones, and would be accompanied by two full-time support vessels. The activities associated with the proposed program include 3-D and/or 2-D seismic surveying, scouting, ice reconnaissance flights, possible crew change flights and associated re-supply activities that are not expected to overlap temporally or spatially with the Proposed Action.

BP Alaska 3D Seismic Survey. BP Exploration (Alaska), Inc. (BPXA) plans to conduct a 3D ocean bottom cable (OBC) seismic survey in the Simpson Lagoon area of the Alaskan Beaufort Sea during the open water season of 2012. The proposed OBC seismic survey will use three source vessels to acquire data both within and outside the barrier islands. The airgun array towed behind the two main source vessels will consist of two sub-arrays, each with eight 40 cubic inch (cu in) airguns, totaling a 640 cu in discharge volume when all 16 airguns are operational. The mini source vessel will tow one sub-array of eight 40 cu in airguns for a total discharge volume of 320 cu in. The 3D seismic survey project is not expected to overlap temporally or physically with Proposed Action

Pacific Arctic Group (PAG). Ongoing activities in the general Beaufort Sea and Chukchi Sea regions include multinational efforts carried out by the Pacific Arctic Group (PAG). Organized under the International Arctic Science Committee (IASC), the PAG mission is to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest to the Arctic region. Some of these activities could coincide in time and space with Shell's proposed exploration plan activities. The Diversified Biological Observatory is a multi-national cooperative effort coordinated by the PAG, with the USA, Canada, Russia, Japan, China, and Korea contributing cruise data from past, ongoing, and planned research programs. The programmatic sampling includes continuation of collections from prior and existing research stations, including BOEM-funded projects. Focus is on four geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. This work includes the synthesis of studies in fields including physical oceanography, marine chemistry, biological oceanography and marine biology (primary productivity, zooplankton, phytoplankton, ice algae, epontic, pelagic, and benthic collections), and marine mammal and marine bird ecology (PAG, 2011).

Bowhead Whale Feeding Ecology Study (BOWFEST). August–September 2012. NOAA's National Marine Fisheries Service (NMFS) and National Marine Mammal Laboratory (NMML). The BOWFEST (NMML, 2011a) is a multiyear BOEM funded study which was started in 2007 that focuses on late summer oceanography and prey densities relative to whale distribution over continental shelf waters within 100 miles north and east of Point Barrow, Alaska. NMML will conduct aerial surveys, acoustic monitoring, and boat-based surveys to provide information on the spatial and temporal distribution of bowhead whales in the study area.

2012 Low-level Aerial Coastal Survey. This plan includes implementation of aerial surveys of coastal areas to approximately 23 mi (37 km) offshore between Point Hope and Point Barrow. These surveys will continue until exploration drilling operations in the Chukchi Sea are completed. Flight altitudes and speeds will comply with LOA and 4MP guidelines. These flights will occur in addition to activities described in the Aircraft Traffic section of this appendix. Saw-tooth flight 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. "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.

Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA). Mid-June – 31 October, 2012. NMFS and NMML. The Northeast Chukchi Sea aerial cetacean survey COMIDA (NMML, 2011b) is a BOEM-funded project designed to understand the distribution and relative abundance of cetaceans by using aerial surveys during the open-water (ice-free) months, from mid-June to the end of October. Surveys follow standard line-transect protocols. Flights begin and end in Barrow, AK. The science team flies in either a

De Havilland Twin Otter Series 300 or Aero Commander 690A fixed wing aircraft at altitudes between 1,000-1,500 feet and at 100-110 kts speed. Surveys are flown every day, weather permitting.

2012 Shell Chukchi Sea Biological Monitoring Program. Concurrent with its exploratory drilling program, Shell will implement a comprehensive environmental monitoring program. A dedicated science vessel staffed by a team of biological, chemical, and physical oceanographers will be responsible for assessing pre-, during, and post-drilling components of biota and water and sediment quality. Shell's proposed drilling locations have been sampled at multiple times during the last three years to provide a baseline understanding of pre-existing conditions and interannual variability at these sites. Physical oceanography characteristics that will be monitored continuously at each location throughout the drilling process include surface wind direction and speed, ambient air temperature, current speed and direction throughout the water column, water temperature through the water column, and salinity through the water column. Water chemistry and characteristics that will be monitored will include assessment of metals and organics through the water column at multiple fixed and random locations around the exploration drilling operation. These measurements will be made regularly before, during, and after drilling, and will capture conditions during all significant phases of the exploration drilling operations and potential discharges. Physical characteristics of the water column will also be assessed (including turbidity, temperature, and oxygen content) in an effort to document and model plumes of released discharges. Samples of biota will be collected before and after operations for tissue analysis for metals and organics. Bird and mammal observations will be made from all of Shell's support vessels throughout the exploration drilling activities in accordance with the 4MP and Bird Strike Avoidance and Lighting Plan.

2012 Conoco Phillips Chukchi Sea Environmental Studies Program (CSESP). The existing environment in the vicinity of the Devils Paw prospect has been studied since the early 1970's. The CSESP, funded by COP, Shell, and Statoil, has voluntarily conducted and participated in comprehensive environmental studies within and near the prospect in 2008 through 2011 and will continue at least through 2012 to gather baseline data on biological, chemical, and physical resources in the proposed prospect area. These studies include biological, chemical, geological and physical oceanography work utilizing acoustics, sea floor sediment sampling, contaminant studies, plankton community assessments, benthic and pelagic invertebrate studies, marine fisheries studies, distribution and abundance of seabirds, marine mammal acoustical monitoring, observation and ecology, and marine archaeology. In addition to these baseline studies, COP will be implementing a comprehensive environmental monitoring program that encompasses the study of the before, during, and after environments that would be affected by the proposed exploration activities, utilizing methods similar to those described for the Shell monitoring program in the previous paragraph.

Hanna Shoal Ecosystem Study (Hanna Shoal). July – October 2012, with similar proposed operating schedules through 2016. This research project will include benthic sampling, food web analysis, and contaminant measurements and focuses on the Hanna Shoal area, located between the boundary of the Chukchi Sea and Arctic Ocean waters and the Burger prospect. Water column primary and secondary production and biomass also will be measured. Cruise zooplankton data will be supplemented by data from moored zooplankton-sensing acoustic Doppler current profilers (ADCP) (units that are capable of distinguishing copepod and euphausid biomass signatures). Moored and shipboard instruments of currents, sea ice drift, and hydrography (including geochemistry) will examine circulation and density fields. Instrument moorings will be used for long term profiling of temperature and salinity, including under ice measurements in winter. Additional oceanographic data may be obtained from other projects such as the proposed extension of the Chukchi oceanographic study. These data include HF radar, moored ADCPs, meteorological buoys, and gliders. Formal integration with the results of other BOEM-funded projects will be made through the planned "Marine Mammal/Physical Oceanography Synthesis" to provide upper trophic components to the study. Coordination will occur with other international, NSF, NOAA, ADEC, and industry research in the Chukchi Sea.

3.5. Oil and Gas Related Activities

Past oil and gas related activities in the Beaufort Sea and Chukchi Sea OCS include exploration wells, exploration seismic surveys, shallow geologic hazards surveys, geotechnical sampling programs, baseline biological studies and surveys, biological, chemical and physical oceanography monitoring programs, and other environmental studies and sampling programs including ongoing work funded by industry for the purpose of understanding the environment within and outside the project areas.

Current reasonably foreseeable oil and gas activities in the Arctic OCS during 2012 include Shell's proposed exploration drilling programs on leases in their Beaufort Sea and Chukchi Sea project areas. Activities from these programs may overlap temporally with the ION 2012 Proposed Action. Shell proposes using dedicated and independent drilling and support vessels for the Chukchi Sea and Beaufort Sea operations, with some shared oil spill response resources. Weather, ice, and other environmental conditions at the specific locations would ultimately determine the sequence and duration of Shell's operations. These proposed projects would concurrently occur temporally but not geographically.

3.6. Climate Change and Ocean Acidification

Climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region (NOAA, 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Chukchi Sea. These changes have been attributed to rising carbon dioxide ($CO_{2)}$ levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world's oceans. These changes have also led to the phenomena of ocean acidification (IPCC, 2007; Royal Society, 2005). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that are leading to increased CO_2 levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to climate change (Bates and Mathis, 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the ocean. This is due to the loss of sea ice that increases the surface area of the Arctic seas. This exposure of cooler surface water lowers the solubility of calcium carbonate, resulting in lower saturation levels of calcium carbonate within the water that in turn leads to lower available levels of the minerals needed by shell-producing organisms, such as pteropods, foraminifers, sea urchins, and molluscs (Fabry et al., 2009; Mathis, Cross, and Bates, 2011).

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